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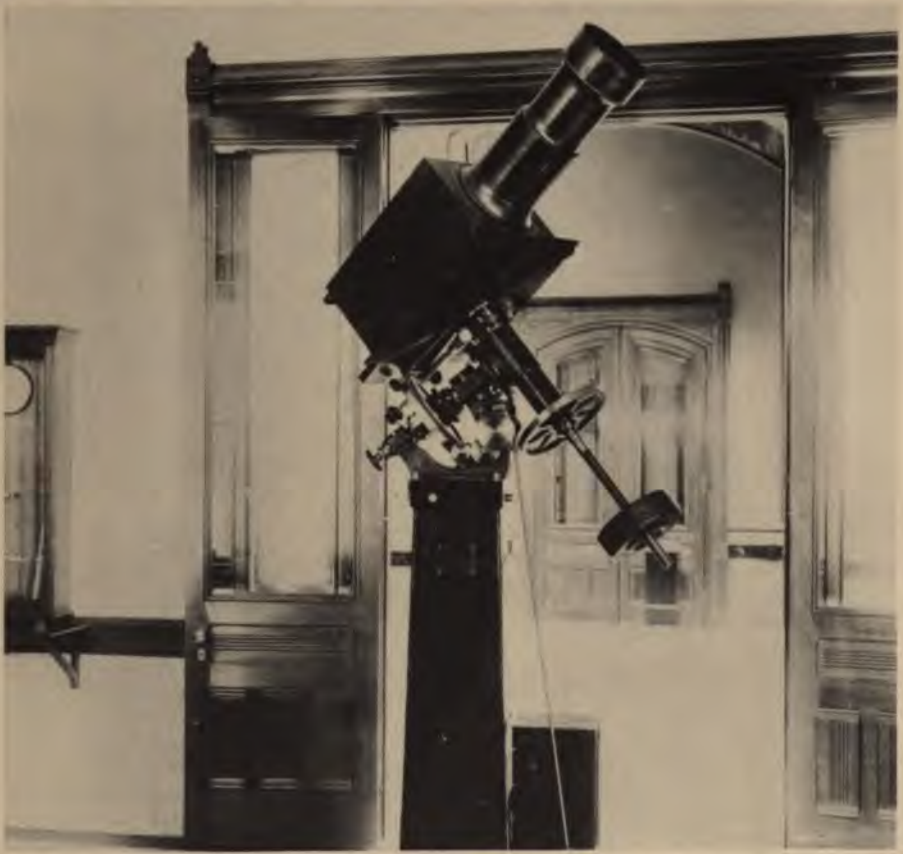

THE CROCKER DOME OF THE LICK OBSERVATORY.

THE CROCKER TELESCOPE WITH SIX-INCH WILLARD LENS PHOTOGRAPHED IN THE CORRIDOR OF THE LICK OBSERVATORY.

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PHOTOGRAPHS OF THE MILKY WAY AND OF COMETS

MADE WITH

THE SIX-INCH WILLARD LENS AND CROCKER TELESCOPE

DURING THE YEARS 1892 TO 1895

BY

E. E. BARNARD

ASTRONOMER IN THE LICK OBSERVATORY

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α 1855.0		δ 1855.0	Subject.	Plate No.
h	m	°		
0	32	+62.9	Region of γ Cassiopeiæ	2
0	35	+40.9	**Andromeda** Nebula	4
0	42	+41.1	Region of the **Andromeda** Nebula	3
0	44	+60.0	Region of γ **Cassiopeiæ**	5
1	20	+65.5	In **Cassiopeia**	6
1	32	+59.2	In **Cassiopeia**	7
1	38	+63.3	Region of ε **Cassiopeiæ**	8
1	58	+57.0	Near the Double Cluster of **Perseus**	9
2	8	+ 8.2	In **Cetus**	10
2	48	+53.2	In **Perseus**	11
3	8	−28.9	In **Eridanus**	12
3	35	+27.0	In **Taurus**	13
3	38	+24.0	**The Pleiades**	14
3	40	+24.0	**The Pleiades**	15
3	47	+35.9	Region of Dreyer 1499	16
3	50	+36.0	Dreyer 1499	17
4	23	+17.4	Region of the **Hyades**	18
4	52	+40.9	Region near η **Aurigæ**	19
5	28	− 5.0	Region of the Great Nebula of **Orion**	20
5	44	+ 8.0	Region of α **Orionis**	21
6	0	+24.5	Region of M35	23
6	4	+12.0	In **Orion**	24
6	6	+25.0	In **Gemini**, near M35	22
6	6	+15.5	In **Orion**	25
6	22	+ 5.0	In **Monoceros**	26
6	22	+ 5.0	Region of Dreyer 2237	27
6	30	+10.0	Region of 15 **Monocerotis**	28
6	34	+13.0	In **Gemini**	29
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8	35	+20.7	Region of **Præsepe** in **Cancer**	33
12	14	+27.3	Region of **Coma Berenices**	34
15	54	−18.1	Near β and ν **Scorpii**	35
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17	55	−28.0	**Great Star Clouds in Sagittarius**	49
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18	33	− 6.9	In **Aquila**	62
18	41	− 7.0	Near **M11**	63
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18	54	+14.3	Near ζ **Aquilæ**	66
19	12	+ 2.5	In **Aquila**	67
19	14	+14.8	In **Aquila**	68
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INTRODUCTION.

ACKNOWLEDGMENTS.

In the later days of my connection with the Lick Observatory it became my desire to see a number of the star and comet photographs that I had made collected into a volume. The expense of reproducing the pictures prohibited this, unless outside financial help could be obtained. It became my duty, therefore, to secure, if possible, the necessary money for this purpose. This was successfully accomplished through correspondence and by personal interviews. No serious difficulty was experienced and I can not help but be grateful for the friendly manner in which all the contributions were made. The total amount thus contributed was $2,225.

I would gratefully acknowledge my indebtedness to the generosity of the following persons whose liberal contributions made possible the reproduction of the photographs for this volume:

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Mingled with the pleasure of finally bringing out this volume is the sad knowledge that since the contributions for the work were made a number of the subscribers have passed on to their final rest.

In conclusion, I wish to express my deep obligations to Professor W. W. Campbell, Director of the Lick Observatory, for many courtesies, and especially for help in the final publication of the volume.

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I am indebted to Professor E. S. Holden, former Director of the Lick Observatory, for placing the Crocker Telescope at my disposal for the work of securing these photographs.

To Mr. Clarence Hough, president of the Chicago Photogravure Company, I am indebted for many courtesies, and to Mr. A. B. Brunk, superintendent of the above firm, I owe everything in the way of excellence that pertains to the reproductions. With unbounded patience and skill, and with a deep interest in the outcome, he has endeavored in every way to produce the best possible work.

I also owe many obligations to Professor E. B. Frost, Director of the Yerkes Observatory, and to Professor George E. Hale, Director of the Solar Observatory of the Carnegie Institution, for courtesies extended to me at various times during the progress of the work.

THE REPRODUCTIONS.

The very great delay in the appearance of this volume of photographs can only be attributed to the writer's anxiety to secure the best possible reproductions of the original pictures. Various methods of reproduction were tried, only to meet with disappointment and failure. The process, finally adopted, is known as the "collotype," which consists of a printing surface on a ground glass plate, that can be used for ink printing in the ordinary press. This process is capable of giving excellent results in the hands of an expert, but under ordinary conditions it is undesirable from the various difficulties that beset it, apparently, on all sides.

The work was begun in 1895–6, and thirty-six plates were then completely printed. The reproductions becoming unsatisfactory, it was abruptly stopped. These thirty-six plates were paid for by the writer, personally. Eleven complete sets were finally rejected, so that only twenty-five of those first printed are used in the volume. After some fifteen years' delay the work was again resumed. In the mean time trials had been made of other processes in various cities. The collotype seemed, after all, to be the most satisfactory. Fortunately, the same man was able to take up the work again, and his previous experience with the pictures was of the greatest importance. Hence, to the skill and intelligent interest, and especially to the enthusiasm of Mr. A. B. Brunk, of the Chicago Photogravure Company, belong whatever excellence these reproductions may possess.

The collotype is an old but interesting process, and one not well known to the average person in these days of half-tones. It has some advantage over the half-tone. Lantern slides and enlargements may be made from the pictures, and in the close examination of small stars it avoids the confusion produced by the screen of the half-tone. I have prevailed upon Mr. Brunk to give me an account of the process as worked by him. The work is very delicate, and no written description can present all the little niceties in the actual working, and the difficulties that must be overcome before the result is a success.

THE COLLOTYPE PROCESS.

The illustrations in this volume were printed on cylinder presses from plates prepared by the photo-gelatin process, also known as "collotype," a brief description of which is given in the following: Gelatin solution, sensitised with bichromate of ammonia, is poured over a heavy glass plate, forming thereon a very thin coating which, after having been baked in an oven at a moderate temperature, represents the picture carrier proper, now firmly adhering to the (printing) plate. The image of any given subject is obtained on the plate by slowly exposing its sensitive surface under a negative to (preferably) artificial light. This manipulation is similar to that of the printing of a photograph except that for this process a reversed negative is required. During the exposure, the chromatic gelatin undergoes a change to the effect that wherever the light is permitted to pass through the negative it will harden the gelatin surface and the various degrees of hardening will correspond minutely to the various values of the negative. When the exposure is closed, the plate is bathed in running water for the purpose of fixing the picture and washing the bichromatic salts out of those parts of the gelatin that were not affected by the light.

The changes taking place on the gelatin surface during the exposure, were observed accidentally, at about the middle of the last century, and through another accidental observation, a few years later, it was found that chromatic gelatin, when properly moistened with water, will accept printer's ink in its exposed (*i. e.* hardened) parts in exact proportion to the various degrees of hardening; while the same ink will be rejected by the gelatin in all those parts of the plate not affected by the light, for instance, among others, in the very dense or opaque parts of the negative. The gelatin not having been hardened in these places, holds enough moisture to repulse the greasy ink. Thus the highest lights will appear alongside of heavy shadows together with all the intermediate values as they are shown in a good picture, provided due care has been exercised during the various stages of operation. For best results, it is also quite essential that faultless negatives be used, since the means of eliminating defects in negatives are rather limited with this process, because of its extraordinary faithfulness of reproduction. Negatives afflicted with fogginess should not be used.

In quite a few instances these photo-gelatin prints have been pronounced as being superior to photographs, because the weaker parts of a negative, which often are lost in a photograph, can be well preserved on the process plate through additional local exposures and with the aid of carefully handled burning-lenses.

These process pictures are of great durability and they are not subject to changes like fading photographs.

A. B. BRUNK,
August 15, 1912. Chicago Photogravure Company.

THE "WILLARD" PHOTOGRAPAIC LENS.

The so-called "Willard" lens is of more than passing interest, and a brief account of what is known of it may be of historical value.

Willard, from all I can learn, was not a maker of lenses, but simply a photographic stock dealer. I have been informed that the lenses bearing his name were made by Charles F. Usner in New York City, who, in the early days of photography, made portrait lenses for such stock dealers as Willard & Co. and Holmes, Booth & Hayden. These large lenses were used for making portraits during the wet-plate period of photography. Their great size was necessary to collect as much light as possible and thus to shorten the exposure for portrait sittings. Upon the introduction of the extremely sensitive dry plates they were no longer needed, and much smaller and less expensive lenses were substituted.

The advent of the Willard lens into astronomical work was due to the total eclipse of the Sun, which was visible in northern California on January 1, 1889. Through the influence of Professor Holden, a large number of amateur photographers, especially those in San Francisco and neighboring cities, became greatly interested in this eclipse. Under the general supervision of Mr. Charles Burckhalter of the Chabot Observatory, Oakland, California, these amateur photographers, many of whom were very skillful, were assigned positions on the line of totality to secure, with crude appliances, the best results obtainable in the representation of the corona. Some of the photographs were excellent, especially those taken by Messrs. Wm. Lowden, F. R. Ziel, and Wm. Ireland.

Mr. Ireland was especially fortunate in being able to secure the use of a large portrait lens of some 6 inches aperture and 31 inches focus, which he borrowed for the occasion from Wm. Shew, a photographer on Montgomery Street, San Francisco, who had used the lens, which had originally cost several hundred dollars, for making fashionable portraits (especially in the later sixties). Though Mr. Ireland had no equatorial mounting for the lens, his photographs were very successful, particularly in showing the great extent of the coronal streamers.

Impressed by the excellent results from this lens, Director Holden purchased it from Mr. Shew for the Lick Observatory with funds provided for the purpose by Hon. C. F. Crocker.

I had been endeavoring to photograph the star clouds of the Milky Way with a small Voigtländer rectilinear lens attached to the 6-inch equatorial, but because of the slowness of the lens, had secured but feeble impressions of these clouds. The great light ratio of the old 6-inch lens, suggested that it would perhaps serve my purpose. The results of some experiments which I made with it in photographing the Milky Way were very beautiful and intensely interesting. When the importance of the lens for such astronomical work became apparent, Professor Holden placed it in the hands of Brashear, who refigured it and greatly improved the definition of the star images.

DIMENSIONS OF THE LENS.

The following measures of the lens were made by the writer soon after its purchase by the Lick Observatory:

Diameter of the front lens, 5.85 inches = 148.6 mm.
Solar focus, 42.59 inches = 108.2 cm.
Diameter of the back lens, 6.73 inches = 171.0 mm.
Solar focus, 70.2 inches = 178.3 cm.

The distance from the rear surface of the front lens to the surface of the back lens was 12.8 inches. A diaphragm of 3.83 inches aperture was placed between the two sets of lenses at a distance of 5.54 inches from the front lens.

A recent determination from negatives made in 1895 gave

Focus: 30.66 inches = 778.9 mm.
Scale: 1 inch = 1°.81; ∴ 1 cm. = 0°.71.

A small lantern lens was also frequently used. Indeed, it was with the lantern lens that the remarkable nebula of ν **Scorpii** was discovered.

THE WORK WITH THE LENS.

The early Milky Way and comet photographs were made with the "Willard" lens in a wooden camera box strapped onto the 6½-inch equatorial as a guiding telescope. The photographs of Swift's comet were thus made. Afterwards the lens, in its wooden box, was transferred to an ordinary equatorial mounting made by Brashear, and fastened to a flat iron plate which was attached to the upper end of the declination axis (see frontispiece). This mounting, as well as the lens, was the gift of Hon. C. F. Crocker, and the telescope, therefore, bears his name.* This usual form of equatorial mounting did not permit exposures to be carried through the meridian, which, except in south declinations, was a great drawback to the work. The only available means of guiding was a small telescope, of 2.4-inch aperture, belonging to the writer. This was fastened to the wooden camera box.

There was no means of illuminating any spider threads. Fine iron wires were, therefore, inserted between the lenses of a negative eyepiece. These were coarse enough to be just visible, in black relief, on the dark sky. A star in focus would be hidden behind these wires. To render it visible, therefore, the image of the guiding star was thrown slightly out of focus. The intersection of the wires

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*Hon. C. F. Crocker has authorized the construction of an equatorial stand to take the Willard photographic telescope bought by him for the observation of the eclipse of December, 1889. The mounting will be made by Mr. Brashear, and will be provided with a driving clock, controlled in the manner invented by Mr. Keeler. The Willard lens, together with a 5½-inch Dallmeyer camera (lent to us by Mr. Pierson), will be mounted side by side, for the present, and will be employed by Mr. Barnard in making photographs of the Milky Way.—*E. S. H. Publ. A. S. P.* **2**, *128*, *1890*.

placed over this small luminous disc for guiding, produced four small segments of light. During the exposure the illuminated quadrants were kept perfectly equal—the slightest deviation from equality could be detected. This method permits great accuracy in guiding, even with a small telescope, but it requires a brighter star to guide on than usual. For a comet without a bright nucleus, however, the guiding became a serious question, subject to considerable uncertainty, especially if the comet was faint. This will account for the ragged condition of the trails in the case of Brooks's comet. These dark guiding wires were used with the 6½-inch, as well as with the smaller telescope.

For housing the instrument in this form a small observatory building, with a dome and a very wide shutter, was erected near the water tank "Huyghens," where it still stands. (See frontispiece.)

ELECTRICAL PHENOMENA.

To judge from the almost entire absence of electrical storms on Mount Hamilton, one would get the impression that very little electricity was present in any form. While guiding, in making these photographs with the Willard lens, however, the writer frequently met with a singular experience which, while it may not be a new one, was at least an unknown feature to me at the time. Perhaps I may be permitted to describe it in connection with the present work.

On chilly or cold nights I wore an Esquimaux coat made of reindeer skin, and heavy rubber overshoes. Frequently, on bringing the eye to the telescope on such nights a spark would discharge with a slight shock between the eye and the eyepiece. This was extremely annoying, and finally became so disagreeable that it was found convenient frequently to touch the metal of the instrument, which would produce a discharge from the finger instead of from the eye. The probable explanation of this phenomenon is that it was due to the fur coat and the insulation of the rubber overshoes, the body becoming electrically charged like a Leyden jar. The approach of the eye to the eyepiece would discharge this electricity into the telescope from the eye. This phenomenon, under similar circumstances, sometimes occurred in observing with the 36-inch refractor. Neither telescope, at that time, had any electrical appliances.

On one occasion, when going to bed in the early morning, the conditions were such that rubbing the hands over the sheets produced a perfect shower of sparks, apparently threatening to set the sheets on fire.

There were also other similar manifestations of an electrical nature at different times.

THE CONDITION OF THE ORIGINAL NEGATIVES.

A few of the very early negatives have badly deteriorated from a want of complete fixation. These plates are brownish yellow in large areas and can not be copied now (except perhaps with an isochromatic plate and a yellow screen), but fortunately, before this deterioration began, I had made glass positives of these from which duplicate negatives were made. In fact, duplicate negatives have been made of all the originals used in this volume. These are permanent. No serious loss, therefore, has occurred or can occur.

Perhaps in extenuation of this oversight in the fixing it would be as well to say that a worker in the wet plate process (as I had been), was more apt to sin in this respect than a beginner in photography, because, with the collodion process, only a comparatively short fixation was necessary. The same held true for the washing of the negatives—a very little washing serving for a wet plate. My previous experience in wet plate work misled me, so that some of the first negatives (dry plates) were not thoroughly fixed. The effect of this mistake did not show at once, but after some years the negatives became brownish, and will ultimately be destroyed. At present there seems to be no remedy for a negative in this condition. Insufficient washing is not necessarily so fatal to permanency, for if signs of a defect in this direction are detected soon enough, little or no injury will have occurred and the plate can then be thoroughly washed. The effects of incomplete fixation, however, can not be remedied so far as I know, even when the deterioration is detected in its earliest stages.

Some of these early plates were varnished and they seem to have suffered very little. I have noticed some of these carefully, and where certain portions of the film near the edges of the plate failed to be covered with the varnish, the film has gone bad. It is extremely important that the negative should be varnished as a further preventive of deterioration, as it protects the film, the gelatin being very much affected by atmospheric conditions. Above all things, however, the plate must be thoroughly fixed. It is not safe to assume that the negative is fixed as soon as it is cleared in the hypo. To remove a plate from the fixing bath under such conditions is almost certain to insure its ultimate destruction. It should remain in the hypo at least fifteen minutes after it is apparently fixed. A thorough washing is also necessary to remove the hypo from the gelatin.

EASILY REMEDIED DEFECTS IN NEGATIVES.

There is one class of defects, however, that sometimes comes on a negative or positive in the drying, or later by accident, about which I have not seen anything written. If a negative is wet again after it is dry, "tears" will almost certainly form in the drying. Sometimes they occur in the original drying of the negative. These often leave semi-transparent markings. If examined closely, it will be seen that the film is thinner at these points or they will appear as slight indentations. By accident, in the early days at the Lick Observatory, I found the remedy for these. Thoroughly wet the negative again. The markings will quickly disappear. To prevent a repetition of the trouble, remove all the water from the film carefully with absorbent cotton before putting to dry. If drops of water get on a plate when dry they will cause these peculiar markings. Of course the remedy is the same as before. If a negative happens to be near a window and fine snow is blown in on it, wherever a speck of snow touches the plate a minute transparent spot will appear, so that the picture will be full of pinholes. Examined with a glass, these usually appear like small craters with raised walls. They are removed almost instantly by immersing in water as in the other cases. If the surface of the negative has been injured by being rubbed or slightly scratched, the abrasions will show on a print. The "water cure," however, will effectually remove these from the negative if the film has not been cut too heavily. The remedy in all the above cases is almost sure to be perfect; if not, there will at least be a very great improvement in the condition of the negative. In very stubborn cases a prolonged soaking helps. I make mention of these facts because the simple remedy does not seem to be generally known even among those who have had great experience in photographic work.

The above is a slightly modified extract from a paper by the writer (Suggestions in Respect to Photographing Comets with Special Reference to Halley's Comet) in *Pop. Astron.*, **17**, 608–9, 1909.

PHOTOGRAPHS OF THE EARTH-LIT MOON, ETC.

Experiments were made at various times in photographing the earth-lit portion of the new and the old Moon. It was found that an exposure of about 30 seconds, with the quickest plate, was necessary to show this phenomenon well. With the small lantern lens, however, a photograph of this appearance could be secured with one second's exposure.

Photographs were also made of the total lunar eclipses of 1895, March 10 and September 3, for two purposes: First, to see how well the lunar surface could be shown by photography, with such a lens, in a total eclipse, at which time the Moon is usually of a strong red color; second, to see if any small body revolving about the Moon, such as a lunar satellite (which would usually be lost in the glare of the Moon, and which during totality might be outside the shadow and hence fully illuminated) could be found.

For illustration of this non-stellar work, I have selected four photographs of the Moon made with the Willard lens under different conditions of illumination, etc. These are shown in Plate 1. The first two pictures show the night surface of the Moon illuminated by sunlight reflected from the Earth. The first photograph represents the new Moon in the evening sky of 1895, February 26. The second is the old Moon in the morning sky of 1895, August 17.

This phenomenon of the bright crescent embracing the ashy-hued globe of the Moon is sometimes popularly known as the "Old Moon in the young Moon's arms," especially when seen in the evening sky.

One of the lunar photographs which was made in 1895, August, $19^d\ 0^h\ 30^m$ G. M. T., shows the crescent as a mere thread of light. The entire dark part is also shown, but faintly. According to the *American Ephemeris*, new Moon occurred at that time on August $20^d\ 0^h\ 55^m.7$ G. M. T. The photograph was therefore made when the Moon lacked but $24^h\ 26^m$ of new. The thin crescent was a beautiful object to the naked eye. In recent years discussions have arisen over the question as to how near the time of new Moon the crescent can be seen. The photograph will, at least in part, answer this question.

The photograph of the total lunar eclipse of 1895, September 3, shows the Moon's surface illuminated by sunlight refracted by the Earth's atmosphere.

It is not necessary here to add (and want of space prevents it) a third example of illumination of the Moon's surface, *i. e.*, by direct sunlight; the three kinds of lunar illumination being

First—Reflected sunlight.
Second—Refracted sunlight.
Third—Direct sunlight.

A fourth picture of the earth-lit Moon (1895, June 25) with the planet **Venus** near the horn of the lunar crescent, is given as a matter of interest, but is without scientific value.

THE PHOTOGRAPHS OF THE MILKY WAY.

It has been thought best to give on the page facing the picture, where the peculiarities could be readily pointed out, a brief description of the principal features of each photograph, especially in the case of the Milky Way. In general this has been done, but certain regions are worthy of a more detailed account which, for brevity, should be placed in the main text. For this reason a description of the singular regions of **Scorpio** and **Ophiuchus** is printed here.

THE GREAT NEBULOUS REGIONS OF SCORPIO AND OPHIUCHUS.

The main features of the wonderful nebulous regions of **Scorpio** and **Ophiuchus** were discovered by the writer with the Willard lens. It is perfectly proper, therefore, that an account of his further investigations of the same regions with a more powerful photographic telescope should be incorporated here, especially as the regions in question have not been investigated by any other writer.

Through the courtesy and deep interest of Professor George E. Hale, Director of the Solar Observatory of the Carnegie Institution, the 10-inch Bruce photographic telescope of the Yerkes Observatory, was transported in 1905 to Mount Wilson at an altitude of 6,000 feet, where the writer went for the special purpose of further investigating these and other regions of the Milky Way. The following information, therefore, is that gained from the present photographs, supplemented by the additional information from those taken at Mount Wilson.

THE NEBULA OF ν SCORPII.

This object, remarkable as it is in appearance, is of far greater interest in the direct evidence it gives of the obscuration of light in space. This obscuration is manifest at a number of points in connection with the nebula; it runs all the way from a slight cutting off of the stars behind to perhaps a total extinction of their light. The boundaries of the nebula may roughly be taken thus, for 1855.0:

	α 15^{h} 59^{m}	δ -18° $20'$
	16 4	-18 0
and		
	16 10	-21 0
	16 16	-18 50

To the southeast its fainter portions involve the stars BD — 19° 4357, — 19° 4359 and — 19° 4361. The last two are in a dense nebulous mass in which, on the north side, are a thin dark lane and a narrow strip of brighter nebulosity. The two stars are connected with — 19° 4357, which is also nebulous, by a thin thread of nebulosity. North and following are dark regions with apparently very few stars.

The evidence for this obscuration is based upon the following considerations: The sky outside of the nebulosity gives the impression of a uniform distribution of the stars over this part of the heavens, and I think there is no question but that this is actually the case. The edges of the western end of the nebula, near the stars BD — 17° 4511, — 17° 4502 and — 18° 4240 are definitely defined. It will be seen that within the limits of the nebula in this region occurs an abrupt thinning out and dimming of the stars, the line of demarcation being the outlines of the nebula. In the northern and diffused side of the nebulosity, and also in the eastern portion near BD — 19° 4359 and 19° 4361, this thinning out of the stars is remarkable.

One of the strongest facts in this argument is, that at a point 40′ north and west of BD — 19° 4359, or, in 1855.0 α 16^{h} 10^{m}, δ -19° $15'$, a patch of the partially hidden background, about one square degree in area, is seen through an opening in the nebulous matter. The nebulosity can readily be traced all around this opening, perceptibly dimming the light of the stars wherever it falls, but the small space in question is free from it. In reality, these stars are but a part of the rather uniform stellar background which is seen through a hole in the nebulosity from **ν Scorpii**, that partly obscures the stars in this region. On the face of it, this seems a strange statement, but if one examines the evidence it will be seen to be true. In a photograph made with the 10-inch Bruce telescope of the Yerkes Observatory which appears in the *Astrophysical Journal* (Vol. 31, January, 1910, Plate I), this spot of stars is 1.4 inches from the left side of the plate and 2.3 inches from the bottom. It will be seen, further, in that photograph, that this patch resembles exactly, in its clearness and in the number of stars, the background of the sky farther to the north, where manifestly there is no nebulous matter; or, in other words, it is simply the regular sky shining through a hole in the nebulosity. Perhaps the most remarkable thing, however, is that the brighter parts of the nebula seem nearly, if not quite, transparent, the darker portions apparently being the denser and more opaque.

THE GREAT NEBULA OF ρ OPHIUCHI.

One can not look upon a photograph of this extraordinary region without wondering what is really meant by its strange phenomena. I think there is no question that strong indications of light obscuration are shown, though for various reasons the evidence is not so clear as in the case of the nebula about ν **Scorpii.**

First of all, the picture gives the impression that the sky here (as in the case of the ν **Scorpii** region, which is really a part of the present one) shows a uniform distribution of the small stars. Suddenly in this background occurs, apparently, a hole almost free of stars, in which, fitting closely, is the great nebula of ρ **Ophiuchi**. From this hole and nebula several sharply defined lanes run eastward. From the west side of the bright part of the nebula about ρ **Ophiuchi** is a bordering of feeble nebulosity about 45 minutes wide and abruptly terminated at its edges. This feebler nebulosity seems to blot out the stars almost completely. Indeed, all around the nebula, except to the northeast, this obscuring matter is evident. To all appearances the nebula lies in a hole in a rich portion of the Milky Way, with vacant lanes extending from it to the east. Besides the two main masses, σ **Scorpii** is involved in a very strong and irregular condensation with much detail. This condensation is directly connected with the large nebula and spreads out in a faint diffusion for several degrees to the south. The main mass of the great nebula is at ρ **Ophiuchi**. It consists of two condensations whose centers are about 30 minutes apart—the eastern and brighter one surrounding ρ. The northern portion of this part of the nebula is beautifully ribbed. Another condensation, equally remarkable, lies 1 degree south of ρ at the eighth magnitude star CD — 24° 12684. This latter object is very remarkable; from the star as a center, issue four bright whorls of nebulosity which are about 20 minutes to 30 minutes long, the north and south ones being the longest. Some 14 minutes north and slightly east of this star is a singular U-shaped dark marking very sharply defined. Immediately following the star CD — 24° 12684 is apparently a dark whirlpool which is formed at the beginning of the vacant lanes running to the east from the region of ρ **Ophiuchi**. The lower or southern of these lanes, which is one half degree broad, is the strongest marked. Its edges are very clearly defined for about 7 degrees, after which it becomes broken and shattered and ends 10 degrees to the east in an irregular group of small holes or black spots. The northern and shorter of the two most conspicuous lanes is marked for about 2 degrees with very black, irregular and sharply defined rifts and perforations, which unfortunately are lost in the reproduction.

One would hesitate in passing on the character of these dark lanes. Near the great nebula there is every evidence that they are mixed up with the nebulosity and I think obscuration is strongly indicated. The larger and more extended of the lanes is so blank and so definite on its edges that one would almost believe that a long strip of obscuring matter lies between us and the stars here. If we accept this as obscuration due to some peculiar condition of a band of dim nebulosity, such an object would be unique among the brighter nebulosities. At the same time these dark lanes are not infrequently connected with a brighter nebulosity, as in the present case. We have excellent examples of this in the wonderful region in **Taurus** near the feeble nebulosity in $\alpha\ 4^h\ 10^m\ \delta + 27° 55'$ (see "On a Nebulous Groundwork in the Constellation Taurus," *Ap. J.* **25**, 218, 1907), and in the case of the nebula Dreyer *Second Index Catalogue* 5146 (see Plate 81) which is placed at the east end of a dark lane over 1 degree long. At the same time we must admit the presence of feeble extensions of nebulosity near bright nebulæ that apparently do not cut off the light of the stars. A good example of this is the extended nebulosities about the **Pleiades**, which, from their connection with the cluster, are evidently on this side of the small stars. Though these nebulosities are feebly shown in streaks and masses over a region perhaps 10 degrees square, the background of small stars is uniform, and if these small stars are beyond the nebulosities they shine through with undimmed light. Other similar cases might be cited, such as the extension of faint nebulosities eastward from M8 and the great curved nebula in **Orion**, etc. It would appear, therefore, that some nebulæ and nebulosities do not produce this obscuring effect, while it is very marked in others. The **Orion** nebula is a good example of the absence of the general background of faint stars close to a nebula. There is a scattering of small bright stars about the nebula itself, but it is noticeable that the fainter ones are missing close to it. Another striking case of obscuration is the region immediately about M 78 = Dreyer 2068 (also in **Orion**) where the brighter part of the nebula is apparently surrounded for some distance by an obscuring medium which cuts out the light of the stars near it.

Two bright nebulæ, one below and the other above 22 **Ophiuchi**, make with that star an "eye," which is very striking in appearance.

Perhaps it will be well to state here that the remarkable nature of the region about ρ **Ophiuchi** was first shown in my early photographs with the Willard lens. But the presence of nebulosity here had been found by me earlier, in my comet sweeping at Nashville, Tennessee, and it was this knowledge, and the desire to investigate the supposed nebulosity, that led me to make the photographs with the Willard lens which resulted in the discovery of one of the most remarkable nebulous regions in the entire heavens.

While on the subject of this probable obscuration of the stars, it may be well to mention some recent visual observations which would seem to confirm the idea that the light of the stars may be interrupted by interposing nebulous or other matter in space.

In the *Astrophysical Journal* for December, 1913, the present writer has shown by visual observations with the 40-inch refractor of the Yerkes Observatory of the small black spot in a dense star cloud in the Milky Way (Plates 54–55), and of the black "notch" in the nebulous stream running south from ζ Orionis (Plate 20) that they are not true vacant sky, but apparently consist of dense, feebly luminous matter which is more or less opaque. In the article referred to, the following statements are made with respect to these two bodies:

> *The Small Black Spot in [1855.0]* $\alpha\ 18^h\ 7^m\quad \delta\ -18^\circ\ 15'$*:* On the night of July 27 of the present year [1913], the conditions were very favorable, both for transparency and for steadiness. Under these conditions the "hole" or spot was examined very carefully with the 40-inch telescope. With the following edge of the spot cutting across the middle of the field, which is some three times smaller than the spot, it was quite distinctly seen that the preceding half of the field, in which there were no stars, was very feebly luminous, while the following side showed a rich, dark sky with the few small stars on it. From the view, one would not question for a moment that a real object—dusky looking, but very feebly brighter than the sky—occupies the place of the spot. It would appear, therefore, that the object may not be a vacancy among the stars, but a more or less opaque body.
>
> *The Small, Black Notch in the Nebulosity South of ζ Orionis. [1855.0]* $\alpha\ 5^h\ 33^m.6\quad \delta\ -2^\circ\ 35'$*:* On the night of November 4 [1913], with good conditions of seeing and fair transparency, I examined this object with the 40-inch telescope and a power of 460. The position was carefully located with the aid of the photograph. The outlines of the spot—so sharp and clear in photographs of this region—could not be made out with any definiteness. The view showed that the spot is certainly not clear sky, for the field was dull, apparently indicating the presence of some material substance at this point. To me the observation would confirm the supposition of an obscuring medium.

THE PHOTOGRAPHS OF COMETS.

The great comet of 1882 was successfully photographed at the Cape of Good Hope by Dr. Gill, with the aid of a local photographer and his portrait lens. Several naked eye comets appeared later, but nothing of consequence seems to have been done in the effort to photograph them with portrait lenses until the appearance of Swift's comet of 1892. This object, from its brightness, promised much for photography. The photographs obtained of it with portrait lenses showed their very great value for such investigations and fixed the position of this form of instrument as one of the most important in any observatory.

COMET I 1892 (SWIFT).

VISUAL OBSERVATIONS.

This comet was discovered by Dr. Lewis Swift at Rochester, New York, 1892, March 6. Perihelion occurred April 6. (Berberich *A. N.* **130**, 215, 1892.) It was a large comet visible to the naked eye at the time of discovery and subsequently. Its greatest theoretical brilliancy occurred in the first half of April. During the period covered by the photographs, it was receding from the Earth and diminishing in brightness. Following are notes on its visual appearance:

1892, March 7^d $16\frac{1}{2}^h$.* Easily visible to the naked eye; as noticeable as a sixth magnitude star. The finder of the 12-inch telescope showed a tail about 15 minutes long. In the 12-inch, the comet was large and round and 7 or 8 minutes in diameter, with an almost stellar nucleus, of the eleventh magnitude, in the middle of the nebulosity. Though no tail was seen, its presence was indicated by the haziness of the sky near the head.

March 8^d 17^h. With the eye the comet was at least fifth magnitude. It was a little brighter than Davidson's comet of 1889.

March 9^d 17^h. Moonlight. The comet was very noticeable to the naked eye. The head was somewhat brighter than M8. It was like a hazy star and about as large as the **Orion** nebula appears to the naked eye, but brighter, and could not have been missed in a casual glance at the sky even in moonlight. The nucleus was not stellar in the 12-inch.

March 15^d 17^h. It was quite visible to the naked eye, like a star of the fifth magnitude. Nearly full moon. In the 12-inch the nucleus was eleventh magnitude, but no tail could be seen.

March 21^d 17^h. Through breaks in clouds. To the naked eye it was a large, hazy spot of the third or fourth magnitude.

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*The time given in all of these observations is Pacific Standard Time, which is 8^h 0^m slow of Greenwich Mean Time.

April 3ᵈ 16ʰ 20ᵐ. The comet was bright to the naked eye with a faint, slender tail which reached faintly to the star BD — 8° 5150 (5ᵐ.8) but not beyond it, a length of about 18°. This star was touching the south edge of the tail, which also passed close to the north of BD — 5° 5378 (4ᵐ.2)—just free of the star.

April 4ᵈ 16ʰ. Sky very thick. The head was slightly inferior to a third magnitude star. The tail was about as long as on the 3d.

April 5. In clouds.

April 6ᵈ 16ʰ. The comet was conspicuous to the naked eye. The tail was visible for about 25 degrees and not quite 1 degree wide. The star BD — 3° 4961 (5ᵐ.4) was in the north edge of the tail, while BD — 3° 4906 (6ᵐ.4) and BD — 3° 4918 (5ᵐ.5) were in the axis of the tail. The nucleus was suspected to be double with the 12-inch [perhaps this had something to do with the mass shown in the tail on the 7th].

April 7ᵈ 16ʰ 15ᵐ. The star BD — 3° 4961 was in the axis of the tail (which extended several degrees beyond the star). The head was equal in brightness to BD — 10° 5506 (4ᵐ.2).

April 18. First clear night for a long time.

April 22ᵈ 15½ʰ. To the naked eye the comet was as bright as BD + 9° 4732 of the 4.0 magnitude, with a tail 8 degrees long. A starlike nucleus was visible in the 6-inch guiding telescope. The driving clock refused to work and the guiding throughout on this date was done by hand.

April 24ᵈ 15ʰ 30ᵐ. The tail passed over BD + 14° 4668 (6ᵐ.5) and extended 5° beyond M 15. To the eye the nucleus was brighter than BD + 11° 4784 (5ᵐ.5).

April 26. Sky veiled with haze. To the naked eye the comet's head was brighter than BD + 11° 4784.

May 22ᵈ 14ʰ. No tail was visible to the naked eye, but the head was of the fifth magnitude.

May 23. Head alone visible to the naked eye, like a star of five and one half magnitude.

May 29ᵈ 14½ʰ. The comet was still faintly seen with the naked eye.

May 30ᵈ 14ʰ. About sixth magnitude, but with no tail.

DESCRIPTION OF THE PHOTOGRAPHS.

1892, April 4. The tail consists of three widely diverging streams of matter. The two outer ones do not meet in the center of the head when prolonged, but seem to proceed more from the sides as if they were branches of a parabola that curved around the central brightness of the head. The main central streamer is double and fragmentary, part of the way. The north side of it is concave and at a distance of 2°.5 from the head suddenly becomes straight and nearly parallel with the south side of the streamer. There are a number of faint diverging streamers on both sides of the head—mainly on the north.

April 5. The tail gradually widens, the edges being stronger. Near the head the south portion is separated from the main tail and is connected with the head by a narrow, faint streamer.

April 6. The tail consists of two broad branches, the north one of which is the broadest and heaviest. This north branch has an abrupt bend in it toward the south at 39 minutes from the head. At this point there are a number of condensations. At 2°.8 from the head, the south edge of the north branch is strongly curved toward the south. Between the condensations and the head, the tail seems to be made up of a great number of separate strands more or less diffused, many of which do not seem to originate in the center of the head. The south branch is rather faint and broad.

April 7. The tail is separated into four or five slender diverging threads near the head, three of which are strongly marked. The two north ones are very long and slender and the south one—apparently the main one—is more or less convex to the north near the head, and at a distance of 1°.9 widens out into a great mass from which, apparently, a new system of streamers originates. The nucleus is visible in the center of the head and the two outer streamers would form a parabolic curve around it.

April 18. The head is small. The tail is formed of a bundle of widely diverging, slender streamers, some of which are bent and curved near the head.

April 22. The tail consists of three main broad diverging streamers, with several short and diffused ones from the sides of the head, which itself is small. It very much resembles the photograph of April 4. The north side of the middle streamer is concave and well defined and makes a rather abrupt change of direction. Farther out, at a distance of 1°.9 from the head, this separates into several streamers. At 5°.6 from the head is a long, diffused condensation.

April 24. The head is small and the tail consists of a number of diffused, broadening streamers, the central one of which is very strongly defined and irregular. About 1°.9 from the head a large portion is missing from the north side of the tail.

April 26. A large defect occurred in development which covers a portion of the tail. Through this defect the tail can be freely traced. The head is small. The tail, near the head, is made up of a bundle of six or eight diverging streamers, but the main tail consists of three strong streams the central one of which is double, two narrow strong streamers forming a border to it.

May 22. The tail consists of a slender, long streamer with some slight curvature on the north side at 28 minutes from the head. Farther out, it separates into several feeble strands, while near the head, especially on the north side, are a number of very thin, faint, short streamers.

May 23. The tail consists of one rather long, straight streamer. On each side of this is a widely diverging streamer giving the impression that if a longer exposure could have been made the tail would have consisted of three diverging main branches, very much like those of April 4.

May 30. The tail is short and apparently consists of a longer streamer on the south side and a short one on the north at a considerably different angle, the one on the south being more or less disconnected from the head.

POSITION ANGLES AND LENGTH OF THE TAIL.

The following position angles of the main axis of the tail were taken off from the BD charts with the aid of a large protractor:

	Position Angle.	Length of Tail.	
1892 April 4	261°	7°	to edge of plate
5	257	7	to edge of plate
6	257	7	to edge of plate
7	257	7	
18	260	8	
22	263	11	
24	261	6	
26	262	5	
May 22	262	6½	
23	263	10	
30	255	2	

DISCOVERY OF COMET V 1892.

On the night of 1892, October 12, in my regular work of photographing the Milky Way, I gave an exposure of $4^h\ 20^m$ with the Willard lens on a region a few degrees west of **Altair** (Plates 71 and 101). When the plate was developed and examined, a short hazy streak was found on it in the position (1855.0) $19^h\ 30^m$, $+12^\circ\ 50'$. A comparison with another plate, which I had taken of the same region on September 26 of that year, and on which the object did not appear, showed that it was probably a new comet. On the night of October 13, this object was located with the 12-inch telescope and found to be a faint comet moving toward the southeast. With the 12-inch it was faint and round with a slight central brightening, but with no nucleus. The comet was estimated to be twelve and one half or thirteenth magnitude. (See *A. J.* **12**, 102, 277, 1892–3.) The trail, 9 or 10 minutes long and very diffused, is a little brighter along the axis. It is a conspicuous object near the middle of the plate.

This comet has been shown by M. J. Coniel (*Bull. Astron.* **12**, 245, 1895) to have a period of about six and one half years. It was due to return in 1899 and 1905–6 and also in 1911, but it has not been seen since 1892.

Perhaps it may be well to state here that this was the first comet discovered by the aid of photography.

COMET III 1892 (HOLMES).

This comet was discovered by Mr. Edwin Holmes in London on November 6, 1892. According to Prof. Lewis Boss, perihelion occurred 1892, June 13.

From several points of view, it was one of the most remarkable comets that has been observed. At the time of discovery it was distinctly visible to the naked eye as a star of the sixth magnitude or brighter, which, in the telescope, resembled a sharply defined planetary nebula. There is every evidence that, from a rather faint object, the comet must have rapidly attained to naked eye visibility by a sudden outburst of light somewhat similar to that of the **Novæ**. On January 16, 1893, after having gradually faded away for a couple of months, until it was excessively faint and diffused in the telescope, it once more suddenly became a bright star-like object—as bright as the seventh or eighth magnitude. Then, through a process of diffusion and fading exactly similar to that which took place immediately following its discovery, the comet again became faint, and finally faded from view.

Though this object has been observed at several returns since 1892, it has presented no peculiarities different from that of the ordinary faint telescopic comet, as will be seen from the following brief history:

The comet was discovered at its first predicted return by Perrine at the Lick Observatory on 1899, June 10. It was observed by Aitken with the 36-inch in August and September (*A. N.* **151**, 29, 1900). He described it as being very faint—not as bright as the fourteenth magnitude star. At this return, it was also observed by the writer at the Yerkes Observatory on eight dates from August 15 to November 7, and was described as ranging from thirteen and one half to sixteenth magnitude, with a very faint nucleus part of the time, and feebly brighter in the middle. At this time there was nothing to distinguish it from the ordinary faint telescopic comet. During this apparition (1899) it seems to have been observed only at the Lick and Yerkes observatories.

At the return of 1906 the comet must have been very faint. No visual observations seem to have been made. A number of photographs were secured of it, however, by Dr. Max Wolf at Heidelberg, so that the return was fully verified. (*A. N.* **172, 173,** *passim*, 1906, 1907.)

From the faintness at the returns of 1899 and 1906, one would rather infer that previous to 1892 it had been an ordinary periodic comet, whose faintness had prevented its earlier discovery, and that the outbursts of light and attendant phenomena of 1892 were caused by some accident which happened to it at that time—due, possibly, to the peculiarity of its orbit and its relation to the asteroid zone.

So great is the interest attached to the extraordinary phenomena presented by the comet in 1892 and the possible connection they may have with the life history of these bodies, that it would seem that as full an account as possible of the various peculiarities of the apparition of that year should be preserved. As no adequate description of the comet, as seen at that time with a powerful telescope, seems to have been printed by other observers, I have prepared the following condensed notes from my observations of that return.

I would call special attention to the large, irregular mass shown on the photograph of 1892, November 10, about 1 degree southeast of the comet (center in 1855.0 α 0h 45m.2 $\delta + 37° 35'$) covering an area of one or two square degrees, and connected with the comet by a narrow, short strip or tail. I do not question but that this object (which is well shown in Plate 103) had something to do with the outburst of light in the early part of November, 1892. It is a pity that no photographs were taken of the region of the comet on 1893, January 16.

VISUAL OBSERVATIONS.

The announcement of the discovery of this comet was received at the Lick Observatory on November 8, 1892. The comet was observed that night with the 12-inch refractor. Its appearance was absolutely different from that of any comet I had ever seen—a perfectly circular and clean cut disk of dense light, almost planetary in outline with a faint, hazy nucleus and a slight condensation some 5 seconds south following the nucleus. With the naked eye it was just as bright, exactly, as the brightest part of the Great Nebula of **Andromeda**, near which it was visible.

At $8^h\ 0^m$ a careful estimate made the diameter 260 seconds. At $9^h\ 40^m$ micrometer measures made the north and south diameter 286 seconds.

November $9^d\ 6^h\ 5^m$. To the eye, it appeared brighter than on the 8th, and was certainly brighter than the brightest part of the nebula and resembled a small star. It was equal in brightness and almost in appearance to the star 32 **Andromedæ** (BD + 38° 90). It seemed brighter at $8^h\ 30^m$. It was then brighter than 32, and almost equal to ν **Andromedæ** (BD + 40° 171, of $4^m.7$). It was estimated to be nine-tenths the brightness from 32 to ν. This would make it 4.8 magnitude. It was certainly brighter than on the 8th, and with the eye alone would readily be mistaken for a star. At $8^h\ 30^m$ it was examined with the 4-inch comet seeker, with which the diffused haze surrounding the comet could be seen, also faint traces of a tail. With the 12-inch telescope there was a very diffused, faint envelope $12' \pm$ in diameter surrounding the comet with a faint diffusion following. At the center was a slight condensation, which followed the nucleus by $\frac{1}{2}' \pm$. The north preceding edge of the cometary disc was best defined.

November 11. With the 12-inch, the north preceding edge of the comet was very well defined, while south following it was very hazy and diffused. The nucleus, though faint, was almost stellar. Several small stars were shining through the nebulosity, one of which was 20 seconds from the nucleus. The comet more than filled the field of view.

November 12^d 9^h. The comet was certainly a little less bright to the naked eye, and was about the mean brightness of 32 and ν **Andromedæ**, or 5.1 magnitude. It was more hazy to the naked eye than on the few previous nights.

November 13^d 9^h 0^m. The comet was certainly fading. It was about three-tenths or four-tenths the brightness from 32 to ν, or 5.2 magnitude. At 11^h 45^m with the 12-inch telescope, it was considerably larger and less bright and not quite so definite. The measured diameter was 582 seconds.

November 14^d 7^h 40^m. In the 12-inch, it was larger and fainter and more diffused. The measured diameter was 546 seconds. At 9^h, the comet was fainter to the naked eye. It was but little brighter than the star 32 **Andromedæ**.

November 16. In the 12-inch, the comet was not dense—a remarkable change from its previous well defined appearance. It was much larger, some 10 minutes in diameter, and fainter—through diffusion, apparently—and the edges were not so well defined. There was nothing about it different from other comets, except its size. The north preceding edge was best defined while the south following was diffused. Preceding the center was an ill defined nucleus from which a diffused brightening extended south following. At 7^h 20^m, to the naked eye, it was a little less bright than the mean between 32 and ν **Andromedæ** and was star-like. It was considerably brighter than BD + 36° 148 (6^m.5), about 1° ± south-east of it.

November 21. The comet was 15 minutes in diameter, very diffused south following, with a feeble brightening near the middle. The north preceding edge, though not diffused, was very dim and hazy. It was very much fainter than 32 **Andromedæ** and was just fairly visible to the naked eye.

December 5. The comet was extremely diffused, especially south following, but was very easy with the 12-inch. It was about twelve and one half magnitude. The more diffused part was 20 minutes in diameter. By sweeping rapidly, the comet seemed to diffuse over a very large area—greater than the field of 42 minutes. A faint condensation was visible in the preceding part with a feeble brightening south following. The preceding edge was a little more definite than the rest, but it was all very vague. In the finder it was very large, diffused and dim.

December 7. The comet was brightest and least diffused when seen in the comet-seeker.

1893, January 4. In the 12-inch telescope it was excessively faint and very large—indefinitely large. With 150 diameters there was only the feeblest trace of it.

January 6^d 16^h 30^m. In the 12-inch the comet was very faint.

January 16. On this date, the sky cleared after dark, which was the end of a cloudy spell of several days duration. Between 6^h and 7^h I set for Holmes's comet with the 12-inch telescope, with little expectation of seeing it again on account of its faintness. A small, bright hazy star presented itself in the field. When examined with a magnifying power of 150, the object appeared small, bright and strongly condensed. Thinking this could not be the comet, a second setting was made with the same result. Still uncertain, a series of measures was made to see if the object was in motion. The results finally showed that it was really the comet. In the finder it looked like an eighth magnitude star. As soon as the measures proved that it was Holmes's comet a telegram was prepared announcing the remarkable change that had taken place in it. Either just before the message was sent by Professor Holden or just afterwards, a telegram from Palisa, at Vienna, came announcing the change. At 9^h 55^m in the 12-inch the nucleus was tenth magnitude and star-like, but it had only been showing for a few minutes. The comet was certainly brightening. By comparison with the stars BD + 33° 232 ($7^m.8$) and + 33° 236 ($8^m.2$) in the finder of the 12-inch telescope, it was 7.9 magnitude, and appeared like a small, bright star—wholly undistinguishable from a star. At 10^h 10^m it was certainly increasing in brightness. The nucleus could then be easily made out and was distinct, though at first it was only suggested. "With 150 it looks exactly like **Nova Aurigæ** with 700 on the 36-inch." At 10^h 20^m there was no question but that the nucleus was brightening; it had become very easy and seemed to have formed during the observations.

With the 36-inch telescope the appearance of the comet was the same as that on November 8 with the 12-inch. Its outline was quite definite and the nucleus was pretty bright, central, hazy and yellow, while the nebulosity was bluish. At 10^h 55^m, with 360 diameters, there was a feeble glow surrounding the comet about 1 minute in diameter. At 11^h 0^m with the 12-inch telescope it was certainly brighter and the nucleus better seen. In the finder it was fully equal to BD + 33° 246 ($8^m.1$).

The following measures of the diameter were made on this date:

h	m	″	
8	15	29.4	(1) with 12-inch telescope
9	50	32.4	(2) with 12-inch telescope
10	30	44.0	(3) with 36-inch telescope
10	43	47.2	(3) with 36-inch telescope
11	14	46.7	(2) with 36-inch telescope

January 17. At 6^h 20^m, with the 12-inch telescope, the comet had a beautiful star-like nucleus, which was surrounded by a disk of fainter nebulosity. At 7^h 9^m the nebulosity was $46''.0$ in diameter. The north edge of the comet was too indefinite to permit more than a rough guess at the setting for the diameter. At 8^h 0^m the nucleus was the most conspicuous object. It was yellowish and just as bright as, but more conspicuous than, the star BD + 33° 247 of the 9.4 magnitude. The nucleus, which at the first observation on January 16 was scarcely visible, was now strikingly conspicuous. In the finder the comet was almost stellar,

though a little hazy—like a small, hazy star, and was of the same brightness as BD + 33° 232 of the 7.8 magnitude. At $8^h\ 45^m$ the nucleus was probably somewhat brighter. At $9^h\ 20^m$ and $10^h\ 35^m$ there was no change in the appearance of the comet or nucleus.

January 18. At $6^h\ 55^m$ the diameter was roughly 90 seconds. In the finder it was of perceptible size, and hazy, compared with the comparison star. With the 12-inch there were only the feeblest traces of a nucleus. The comet was pretty strongly condensed and perhaps not any brighter than on the 17th. At $7^h\ 35^m$ the nucleus was very hard to see, not brighter than the thirteenth magnitude, and placed, possibly, a little preceding the center. The comet was round and much brighter in the middle, but ill defined at the edges. At $9^h\ 45^m$ the nucleus was very difficult and faint, about thirteenth magnitude. It was almost lost in the small brightening that surrounded it. The comet itself was very noticeable and hazy in the finder.

January 19. At $6^h\ 50^m$ a rough measure made the diameter of the comet north and south 121 seconds. There was no limit to the edges of the nebulosity. The nucleus was bright. At $9^h\ 50^m$ the nucleus was twelfth magnitude, but was not distinct.

January 20. At $6^h\ 45^m$, with the 36-inch telescope, the measured diameter was 136 seconds. It was much brighter in the middle, and the edges were not definite. It looked like a great nebulous sphere with a conspicuous nucleus of the tenth magnitude in its center.

January $22^d\ 7^h\ 30^m$. With the 36-inch the comet was very diffused and about 3 or 3½ minutes in diameter. The nucleus, which was hazy and indistinct and of the twelfth magnitude, was difficult from the dense glow about it.

January $23^d\ 8^h\ 0^m$. In the 12-inch the comet was about as before, except that the nucleus was very indistinct and hard to see.

January 24. Moonlit sky. In the 12-inch the comet was brightish and cometary looking—quite large and conspicuous as a considerable nebula. It was whitish and dense and somewhat brighter in the middle.

DESCRIPTION OF THE PHOTOGRAPHS.

1892, November 10. The comet consists of a sharply defined, dense, circular disc 8 minutes in diameter, somewhat diffused on the north following edge. This is surrounded by a fainter, diffused, circular nebulosity 19 minutes in diameter. Straggling from this towards the southeast is a faint nebulous strip which widens out into an irregular mass whose center is 48 minutes from the center of the comet and which is 39 minutes in diameter.

November 16. The comet is a rather sharply defined, dense, circular disc 16 minutes in diameter, the south following edge of which is more or less diffused.

Through this disc several star trails are visible. The exterior and fainter nebulosity has disappeared and there is no trace of the diffused mass south following the comet.

November 18. The comet consists of a circular, rather sharply defined disc of unequal density 15 minutes in diameter through which star trails are visible. The south following edge is diffused as if brushing out to form a tail. There are slight traces of a diffused glow about this disc, which may be 28 minutes in diameter. Nothing is shown of the mass of November 10 south following.

November 21. The comet consists of a circular disc 19 minutes in diameter, very diffused on the following side, but fairly sharply defined preceding. A great many stars are seen through this, one of which, just within the preceding edge, is bright. There are no evidences of exterior nebulosity.

December 8. The comet is large, about 25 minutes in diameter, and rather faint with a great number of stars shining through it. The preceding edge is definite, but the following side is diffused. Preceding the center is a definite nucleus from which a slender brightening runs to the following edge of the comet.

In connection with these observations it is important to refer to the visual observations of the spectrum of the comet which were made by Professor Campbell at the Lick Observatory. (See *A. N.* **131**, 211, 1892.)

> The spectrum of the very interesting comet discovered by Holmes is of an extreme type and probably unique. Visual observations made November 8 and 9 showed a continuous spectrum for all parts of the comet. It extended from near *D* to above *G* for the nucleus, for the very condensed and nearly circular coma (about 5′.5 in diameter), and for the very condensed tail seen within this coma. Outside the coma, in the direction of the tail, a very faint glow was just visible in the high power finder of the spectroscope (which would probably be seen to better advantage under low power). This, also, gave a continuous spectrum, though very short, in the yellow and green. The position of maximum brightness in the spectrum was near λ 515, which doubtless was due to the presence of a slight trace of the usual green band. But, except for the fact that the maximum brightness was higher than is generally the case in continuous spectra, it would have escaped detection. The increased brightness was more noticeable in the spectrum of the very faint parts of the comet than in that of the bright parts. There was possibly a trace of the yellow band; but, if so, it was exceedingly faint.
>
> Photographs of the spectrum extending from $H\beta$ to $H\delta$ show it as continuous, but the wide slit required leaves it in doubt whether the Fraunhofer lines were present or not.

COMET IV 1893 (BROOKS).

This comet was discovered by Mr. W. R. Brooks at Geneva, New York, 1893, October 16. It had passed perihelion on September 19. During the period covered by the photographs, the comet, though approaching the Earth, was theoretically diminishing in brightness. It was just faintly visible to the naked eye for about one day—October 21. This increased brightness was only temporary and was undoubtedly due to the disturbed condition of the tail on that date. The comet had been carefully looked for with the naked eye under the best conditions previous to this, but the records do not show that it was so visible on any other date.

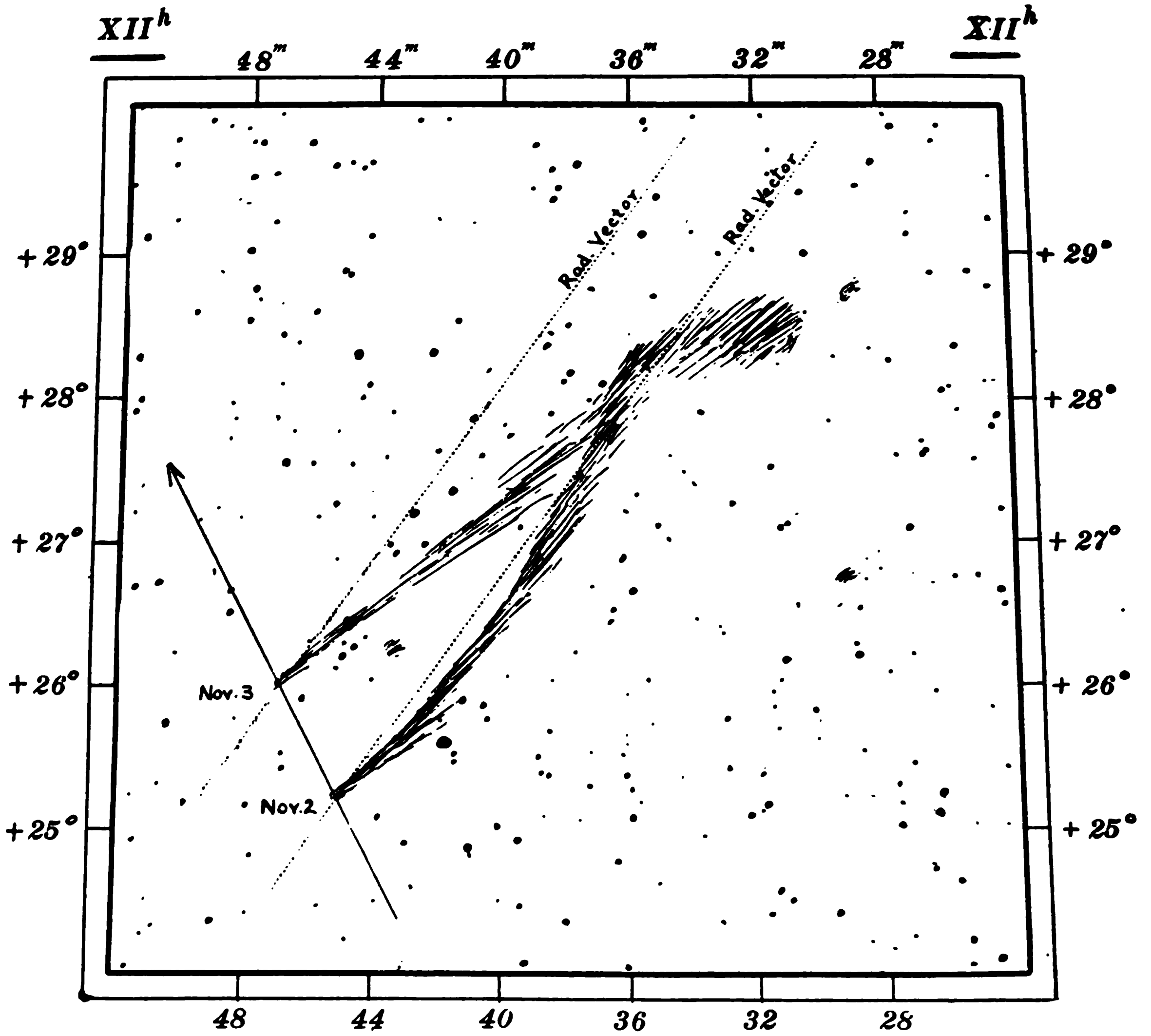

Diagram showing the relative positions of the tail of Brooks's comet and the radius vector on 1893, November 2 and 3.

Brooks's comet should hold an important position in cometary photography for it was the first to show the abnormal phenomena which have so complicated the problems presented by these strange bodies and which, in later years, have added so marked an interest to their study. Another fact also brought out first by this comet was the remarkable photographic activity of its light. Though only feebly visible to the naked eye for one day, and never specially bright as a telescopic object, the fainter features of its tail were well shown with relatively very short exposures—relatively short in comparison with the time required by some of the comets of later years which have been far brighter visually than this one.

Some of the phenomena shown in the photographs of it were unique at the time and they mark an important epoch in the study of comets. There were several periods of great disturbance in the tail, the one that covered the dates October 21, 22 and 23 being the most extraordinary. Though not so striking, the deflections of the tail on November 3 and November 7 are fully as important, because, probably, the same cause was responsible for all these peculiarities. This comet was the first to show these extraordinary "freak" changes, which one would call abnormal. It would seem that these two features—abnormal phenomena and quick photographic action—are, for some reason, closely related. The comets (whether bright or faint) that show the most remarkable and abnormal features seem to be the quickest in photographic action. Under the word "abnormal" I would not include such a phenomenon as the great mass shown to be receding from the head of Swift's comet on 1892, April 7, because this could be easily explained on the assumption that it was a mass of matter expelled from the head which was moving outwards in the direction of the tail. As "abnormal" features, I would include a shattering of the tail such as occurred in the case of Brooks's comet on October 23, etc., which had the appearance of being due to some external force; also, I would include double curvature of the streamers or parts of the tail, and sudden changes in the direction of the tail not accounted for by the motion of the comet such as occurred in Brooks's comet on November 2–3 and 6–7.

VISUAL OBSERVATIONS.

There are but few visual notes on this comet and those, with the exception of October 21, are telescopic.

1893, October 17^{d} 16^{h} 40^{m}. With the 12-inch a nucleus and tail were visible.

October 20. Tried to see it with the naked eye but could not.

October 21^{d} 16^{h} 40^{m}. It was faintly visible to the naked eye as a dim streak about one degree in length.

October 26^{d} 16^{h} 30^{m}. With the 12-inch there was a short tail visible, but the comet was not bright.

October 27^{d} 16^{h} 40^{m}. It was pretty bright, but the tail was dim.

November 2^{d} 15^{h} 20^{m}. The head was pretty bright, but there were only faint traces of tail.

November 6. With a low power on the 12-inch the tail could be traced for less than 1 degree.

DESCRIPTION OF THE PHOTOGRAPHS.

1893, October 18. The head is small. The tail is narrow for 8 minutes and then widens out into a fan-shaped form consisting of the main branch and a smaller branch on the south side. There seem to be some irregular condensations near the head.

October 20. The tail consists of a main branch which is strong, but irregular and gradually widens, and a shorter streamer on the north side at an angle of 25 degrees to the other.

October 21. This is a very beautiful and unique picture. The tail near the head is slender. At about 11 minutes from the head it becomes fainter. It then becomes stronger and curves northward to a point 18 minutes distant. It then irregularly widens and is convex to the north, to a projection on the north side at a distance of 45 minutes from the head. There is another saw tooth projection on the north side at a distance of 54 minutes. From this point on, the tail consists of irregular short diffused strips, and is gently convex to the north. The whole picture strongly reminds one of the ancient descriptions of a comet as a "torch in the heavens." The reproduction is a faithful copy of the original.

October 22. This is a very remarkable picture. The tail near the head for a distance of 11 minutes is diffused with a very short, narrow streamer on the north side at an angle of 15 to 20 degrees. Then begins the main streamer which apparently is disconnected from the head, and which has a sharp definite point in the end towards the head. This streamer is narrow and somewhat irregular and extends to a point about 56 minutes from the head, where it is rather suddenly deflected to the north and continues a short distance further, parallel with its original direction. There are some irregularities in it near the following end. At 50 minutes from the head begins a long irregular mass at a distance of 11 minutes south of the main branch. This runs parallel with the main branch for 17 minutes. Then it is suddenly deflected to the north at a sharp angle and continues parallel with its original direction in an irregular manner to a distance of 2°.7 from the head, where it suddenly turns south and apparently terminates. Beyond this at a distance of 3°.7 from the head is an irregular strip of nebulosity 31 minutes long at nearly right angles to the main direction of the tail and 56 minutes south of its axis. This seems to be disconnected, or at least is connected with the main tail by a very feeble nebulosity. Then in the axis of the main tail, continued, at a distance of 3°.7, completely separated from the other part of the tail, is a larger mass 39 minutes in diameter, slightly elongated in the direction of the main tail. The whole tail in this region has the appearance of being disrupted and shattered by some force moving through it towards the south. The reproduction fairly represents the original.

November 2. The tail is rather slender and very strongly and irregularly concave to the north. It is very irregular, both in form and density, but of nearly uniform brightness to the end. A slender streamer runs tangent to the curvature of the tail for a distance of 1°.1 on the south side. At a point 2°.9 from the head is an abrupt gap in the tail for a distance of 34 minutes which is almost, if not quite, devoid of nebulosity. At 3°.6 from the head, the tail is suddenly bent at an angle of nearly 90 degrees toward the south. This latter portion, which extends for 59 minutes, consists of several cloud-like masses. The north side of the tail is somewhat more definite, the south side being diffused. The general impression given by this picture is that the tail, which was moving toward the northwest, was beating against a heavy current of resistance, like a strong wind, which, near the end of the tail, suddenly became so strong as to bend it abruptly backwards at nearly right angles.

November 3. The tail is somewhat concave and better defined on the south side for a distance of 2°.8 from the head, where it begins to bend slightly to the north and continues to a distance of 3°.7, where there is a large, round mass on its south side, the center of which is 4°.4 from the head. A slender, short streamer running from the head on the north side makes an angle of about 10 to 15 degrees with the main tail. There is a sudden dent in the tail 2°.2 from the head on the south side.

November 6. The head is small and the tail is sharply defined and nearly straight on the north side for a distance of 1°.9, while the south side is more diffused and seems to consist of a great number of short streamers making an angle of about 20 degrees with it. On the north side is a short streamer at a slight angle to the tail. At a distance of 1°.5 from the head is a small, elongated nebulous mass detached from the tail but nearly parallel with it, whose length is 11 minutes and width 3 minutes. At 1°.9 from the head, the tail is suddenly bent to the north and then continues in its original direction in irregular and disconnected masses to a distance of 6°.5, where a larger and more distinct mass is situated, slightly to the north and west of the elongated nebula, Dreyer 4631. This strip is 39 minutes long and less than 11 minutes in width. Its axis runs nearly north and south. Unfortunately this mass, whose center is (1855.0) $12^h\ 33^m.7 + 33^\circ\ 25'$, has been cut out by the mask in the reproduction. Its position would be 0.3 inch to the right of the upper right corner of Plate 112. Part of the nebula (Dreyer 4631) is shown at the right side, 0.25 of an inch from the top, like a "nick" in the edge of the plate.

November 7. The tail, which is long and slender, widens slightly towards the end, and for one half its length is best defined on the south side, and for the rest of the way on the north. It is irregular in brightness, especially at points 1°.0 and 3°.6 from the head. At its end, it diffuses to the elongated nebula (Dreyer 4631) of November 6. A slender, faint streamer runs at a very slight angle to the tail on the south side. The general appearance of the tail, especially near the middle, is that of a slightly wavy streamer.

November 10. This is a beautiful picture. The head is exceedingly small. The tail consists of a main branch which is irregular and widens slightly towards the end and is very narrow towards the head. Two very diffused side streamers appear and extend for 1°.1—one on each side of the main tail. The south one of these is very diffused and wide, the north one less so. At 4°.5 from the head is a brighter condensation.

November 11. The tail is long and slender and wavy. There are several slender streamers on the north side, one of which has its origin at a distance of 1°.5 from the head and extends to a distance of 4°.2. There is a short streamer on the south side of the head, making a slight angle with the tail. At a distance of 4°.2 from the head is a brighter condensation in the tail.

November 12. The tail is long and slender and irregular. There is a short streamer on the south side which is apparently slightly convex to the south. A very slender, long streamer on the north side begins 1°.0 from the head and runs to a distance of 1°.8. The tail apparently terminates at a distance of 5°.0, but there is a continuation of this which has apparently drifted toward the south and is especially strong in the form of an elongated mass at a distance of 7°.5 from the head in the position (1855.0) $12^h\ 37^m.5 + 39°.0$.

November 13. The head is very small. The tail is slender for 22 minutes and then widens slightly and separates into two parts, the south one of which becomes strong and wider and seems to be separated by a narrow, dark strip 1°.9 from the head. After this the tail extends in a fragmentary manner to and beyond the star **α Canum Venaticorum**. An elongated portion near that star, at a distance of 5 degrees from the head, is especially noticeable.

November 14. The head is very small. The tail is slender and of uniform brightness for a distance of 2°.8, after which it becomes very faint and diffused. It is very narrow near the head and at a point 22 minutes distant a part of the tail curves slightly to the north, but a slender thread continues for 54 minutes or so in the original direction. The tail can be traced to the north of and beyond **α Canum** very faintly.

November 15. No. 1. The tail is long, slender and diffused. There is a dark streak running from the head on the south side of the tail for about 54 minutes. The head is very small.

November 15. No. 2. The tail is a little stronger in this plate. The dark streak on the south side is still visible. A diffused streamer from the head runs along the south side of the tail for 34 minutes. This diffuses toward the main tail and the dark streak is seen to be due to a vacancy where the diffusion from the streamer has not yet reached the south edge of the main tail. At a distance of 2°.3 from the head the tail continues in an irregular straggling condition to its end.

November 19. The tail is long, slender and diffused and rather irregular; it seems to be somewhat brighter at a distance of 3°.0 from the head.

REMARKABLE PECULIARITIES OF THE TAIL.

The tail of this comet frequently exhibited very remarkable and unique phenomena. So strange and unaccounted for are some of these that they have suggested the presence of some outside influence, coming neither directly from the Sun nor from the comet itself, as being responsible for them. These peculiarities consisted of disruptions, distortions and deflections of the tail. For a few days the tail would be parallel to itself, and agree with the direction of the radius vector. It would then be thrown forward, and in one case, November 2, the end of it was in *advance* of the radius vector. On two occasions, November 2–3 and November 6–7, the end of the tail remained stationary for a whole day, apparently retarded, while the rest of it, with the head, moved forward in the direction of the original motion. (See Plate 114 and diagram.) In each case the tail resumed its former parallelism as if it had finally been released from restraint. These changes of direction of the tail are not so evident in the individual plates and even in the tabulations they do not forcibly impress one. I, therefore, sought a method that would bring out the peculiarity in a more striking manner. As the comet remained in the same region of the sky, the plates on successive nights would, of course, show the same stars, with the comet in a different position. If, therefore, two negatives on successive dates are carefully superposed, star for star, and copied in a camera, the effect will essentially be the same as if the comet had been photographed on one plate on two successive dates. If no change has occurred in the direction of the tail in the mean time the two tails will be parallel in the composite picture. This method, which does not seem to have been used before (except by the writer), is far more effective in showing changes in the tail than any mere tabulation of position angles could be. Separating the original negatives into pairs, on successive dates, I superposed them thus, for examination. It was found that with two striking exceptions the tails were essentially parallel.

Following are the notes of this examination:

October 18 October 20	Considerably divergent	November 10 November 11	Slightly inclined (converging)
October 20 October 21	Essentially parallel	November 11 November 12	Somewhat inclined (diverging)
October 21 October 22	Parallel	November 12 November 13	Parallel
November 2 November 3	Great deflection of the tail on November 2	November 13 November 14	Parallel
November 6 November 7	Great deflection of the tail on November 6	November 14 November 15	Parallel

To exhibit these peculiarities on the dates of November 2 and 6 I have prepared the two pictures of Plate 114 which show that a strong deflection of the end of the tail occurred on these dates. It is hardly necessary to attempt any explanation concerning these two photographs. They speak for themselves far more forcibly than any description can do. After the changes in direction on November 2 and 6 the tail had again swung back to its normal position on November 3 and 7. A lesser change of this kind took place, also, between November 10 and 11.

In later years a similar, but much more violent case of acceleration of the tail occurred in the case of comet *c* 1908 (Morehouse), on 1908, September 16, when the tail was thrown ahead of the radius vector at a very great angle (*Ap. J.* **28**, 295, 1908).

POSITION ANGLES AND LENGTH OF THE TAIL.

To show the deviation of the tail from the radius vector the following table has been prepared where:

P = position angle of the tail taken from the BD charts.
P' = computed position angle of the radius vector.

		P	P'	$P-P'$	Length of Tail.
1893, October	18	324.0	322.6	+ 1°.4	3°
	20	318.0	322.5	− 4 .5	3½
	21	320.5	322.6	− 2 .1	5
	22	322.6	322.8	− 0 .2	4
November	2	321.7	323.8	− 2 .1	5
	3	305.7	323.8	− 18 .1	5
	6	322.6	323.9	− 1 .3	7
	7	312.7	324.0	− 11 .3	6
	10	320.7	324.2	− 3 .5	7
	11	312.7	324.2	− 11 .5	7
	12	321.0	324.2	− 3 .2	9
	13	319.5	324.2	− 4 .7	6
	14	317.0	324.4	− 7 .4	6½
	15	318.6	324.2	− 5 .6	8
	19	322.2	324.2	− 2 .0	6

The minus sign indicates that the tail lagged behind the radius vector.

On account of the curvature and irregularity of the tail, as shown on the photographs, the measured position angle must necessarily be uncertain, depending, as it does, upon the part of the tail used.

POSSIBLE CAUSE OF THE PECULIARITIES OF THE TAIL.

For a great many years I have called attention to the fact that some of the phenomena of comets' tails have indicated the presence of some kind of disturbing medium which they encounter in space. In the *Astrophysical Journal* for January, 1909, pages 70–71, I have given a brief outline of a theory to account for these changes.

If we accept it as a fact, and I think it is a fact, that the tail of a comet is sometimes broken or changed by some force or influence not directly due to light pressure or to the forces present in the comet itself, it becomes a very important problem to determine what this unknown cause may be. That it is actual matter in the planetary spaces which the tail encounters, does not seem probable. Swarms of meteors (such as we know do exist) might have some such influence, but it would probably be slight so far as attraction or collision is concerned, and could have no effect in producing an acceleration of the tail perpendicular to the radius vector, as is shown to have occurred in the case of this comet in the first part of November, 1893, where the effect was apparently in defiance of the laws of gravitation. No ordinary matter thus encountered and obeying only the laws of gravitation could produce the effect. It has occurred to me (*Ap. J.* **29**, 70, 1909), that a possible explanation of this peculiarity in comets' tails might be found in a similar cause to that which makes the aurora. The latter has been attributed to solar disturbances which produce magnetic storms on the Earth. These disturbing influences—which we will call them for want of a better name—must be going out from the Sun in various directions at more or less frequent intervals. The effect of these upon the attenuated matter of a comet's tail would likely be great, especially in view of the electrical conditions which may exist in the particles forming the tail. We know that the speed of such an influence must be vastly greater than that which could possibly be produced by gravitation. It would not appear that the effect of this disturbing influence should necessarily be radial with respect to the Sun's center. Possibly its action may sometimes be in a curved or orbital direction, such as might produce the acceleration shown in the tail on November 2 and 6. It would not prove that this idea is wrong if we should fail to find a coincidence of auroral display with disturbances in the tail of a comet. These disturbing influences are doubtless more or less local in their direction, and that which would produce a magnetic storm on the Earth might have no effect in the direction of the comet, and of course the reverse of this might be true. The frequent presence of the aurora would only show that the conditions were favorable for disturbances elsewhere in the solar system.

If it is thus true that the influence of a disturbance on the Sun is not widespread in direction in the solar system, it would account for the want of coincidence, sometimes, of an outburst on the Sun with an auroral display, the Earth having been missed, as it were, by the outgoing disturbance.

It may be that these ideas do not appear to be in accord with the known facts so recently established with respect to radiant energy. But this, after all, may not seriously affect them, because we do not yet know all the facts relating to the Sun and space. It is indeed possible that the comet's tail, with its far-reaching sweep across space, may act as a sensitive indicator of the presence of otherwise unknown forces at work in the region of our Sun.

COMET II, 1894 (GALE).

This comet was discovered by Mr. Walter F. Gale at Sydney, N. S. W., 1894, April 1. It passed perihelion 1894, April 13. At discovery the comet was 55½ degrees south of the equator, but it finally became visible above our southern horizon. The nearest approach to the Earth occurred about May 1.

Though the comet was visible to the naked eye, the tail, which was faint, could not be seen without a telescope.

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Following are notes which were made during the brighter period of the comet:

VISUAL OBSERVATIONS.

1894, April 28. With the 12-inch telescope it was a conspicuous object, bright, large and round. It was visible to the naked eye, like a hazy star of the fifth or sixth magnitude and appeared somewhat less in size than the cluster Dreyer 2422. The cluster was about one fourth brighter than the comet.

April 29. The comet was noticeable to the naked eye as a bright hazy spot of about the fifth magnitude. In the 12-inch it was brightly condensed and round—about 6 or 8 minutes in diameter—but with no tail or nucleus.

April 30. It was conspicuous to the naked eye, and brighter than BD—18° 2190 of the 4.5 magnitude. It was large and round in the 12-inch and 6 to 8 minutes in diameter with no trace of tail. The 36-inch telescope showed a very small nucleus of the thirteenth magnitude.

May 2. It was conspicuous to the naked eye as a large hazy star of the fourth magnitude, brighter than the star BD—12° 2385 of the 5.0 magnitude. It was nearly as bright as BD—2° 2450, 4.8 magnitude.

May 3. The sky was thick during the exposure. To the naked eye the comet was a large spot of hazy light, approximately round. Though not so bright intrinsically as the star BD—3° 2339 ($3^m.7$) it was more conspicuous.

May 4. The sky was so thick that it was doubtful if the photographic plate would show anything of the comet. To the naked eye it was easily and conspicuously visible, but not so noticeable as the star BD—3° 2359, 3.7 magnitude.

May 5. Sky good and clear.

May 10. Faintly visible in moonlight with the naked eye.

May 22. Very faintly visible to the naked eye. It was round in the 12-inch with no trace of tail.

DESCRIPTION OF THE PHOTOGRAPHS.

1894, April 29. The head is large, round and diffused. The tail is a mere thread, perhaps double after 34 minutes from the head.

May 2. The head is large, round and diffused. The tail is rather slender and widens slightly. At its connection with the head it is a mere thread.

May 3. The head is large, round and diffused. The tail is long, straight and slender. Very narrow where it joins the head.

May 4. The main tail is very long and slender and slightly widening. This tail does not reach the head but is apparently disconnected at a distance of 45 minutes from it. There are two slender streamers, one north and one south of the main tail, whose intersection would not be at the center of the head. Between these there is considerable nebulosity. In this case it is evident that the supply of matter for the main streamer of the tail had ceased some time before the photograph was made and that the tail was drifting bodily outward into space—a similar case to that of Borrelly's comet, 1903, July 24 (*Ap J.* **18**, 210, 1903).

May 5. The head is large, round and diffused. There is a very feeble streamer from it on the north side of the tail at an angle of about 20 degrees. The tail at first is long and slender—almost thread-like near the head. At a distance of 1°.9 from the head it widens out somewhat on the north side. The south side of the tail continues to the end as a long slender line. The north branch is broader and less definite but well defined. At 1°.3 from the head a fine thread-like line makes its appearance and runs out free of the north side of the tail to a distance of 3°.7 from the head.

May 8. The head is large, round and diffused. The tail consists of one or more faint threads.

POSITION ANGLES AND LENGTH OF THE TAIL.

The following position angles of the main axis of the tail were taken from the BD charts with a large protractor. They are very approximate:

	Pos. Ang.	Length of Tail.
1894, April 29	114°	2°
May 2	113	6
3	105	10
4	112	8
5	115	9
8	108	4

It may not be entirely out of place to insert at this point some further remarks concerning portrait lenses, as the information may be of service to others using this class of instrument.

One of the most important advantages of the portrait lens over other forms of photographic telescopes is its wide field of view, which makes it invaluable for photographing the tails of comets and the great structures of the Milky Way. The same lens can be made to give a perceptibly larger or smaller field, using a flat plate in both cases. This is due to the fact that in such a lens there is a small allowance (which I will call the focal limit) in the determination of the focus, so that a very slight change toward or from the lens will not materially affect the size and sharpness of the images in the center, while at the same time it will affect the field. If advantage is taken of this and the plate kept close to the inside limit, the field of good definition will be slightly increased, while the reverse of this occurs if the plate is at the outside limit. It is, therefore, an advantage to keep close to the inside limit. If the plate is brought nearer the object glass a focal zone (in which the stars are small and sharp) will be produced away from the center of the plate, while at the center all the stars will be perceptibly increased in size. Such a picture is misleading, as it gives the impression that the stars near the middle are brighter and that there are fewer faint stars, when in reality the stars of different brightness may be uniformly distributed over the entire region. This may lead, therefore, to an erroneous idea of the distribution of stars of different magnitudes. This peculiarity has been avoided as much as possible in the present work and this notice is given only as a caution. Plate 31 perhaps shows this peculiarity, where the plate was possibly just inside the focal limit.

To those just beginning work with a portrait lens, a good index of the position of the plate with respect to the focus is as follows:

Larger images in the middle with smaller and sharper images in a zone away from the middle	Plate inside true focus.
Sharpest images at the middle but not small enough	Plate outside true focus.

Fortunately, for portrait lens work, very few plates of glass such as are used for making dry plates are really flat. It seems to be the custom (which is the correct way) to put the emulsion on the concave side of the plate. This materially improves the field of a star plate. Once in a while, but very seldom, however, the emulsion has been put on the convex side. Such a plate will give a bad negative, as the convex surface at the middle will then fall inside the focus, and instead of curving with the focal plane will curve against it.

It is well to mention here that in long exposure work the lens should be protected by a "dew cap" (not long enough to cut down the field of view) to cut out light from parts of the sky other than that being photographed, otherwise a decided fogging effect may be produced by light striking the lens from larger portions of the sky than necessary. This is especially valuable when photographing a comet in a dawnlit or twilit sky.

PERSONAL BIBLIOGRAPHY.

A short personal bibliographical list of papers more or less intimately connected with the subjects of this volume may be of interest. This list, brought up to date, is given here. The following explains the abbreviations used:

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A. J. = Astronomical Journal.
Ap J. = Astrophysical Journal.
A. N. = Astronomische Nachrichten.
M. N. = Monthly Notices of the Royal Astronomical Society.
S. M. = Sidereal Messenger.

MILKY WAY, NEBULOSITIES, ETC.

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IDENTIFICATION OF STARS, NEBULÆ, ETC.

Much time is often wasted in identifying the individual stars on long exposure photographs made with portrait lenses. To facilitate the use of the present plates, it was deemed important to identify a few of the known stars for use in finding the places of others. As it would disfigure the pictures to mark such stars upon them, it was decided to refer their positions to the sides and top or bottom of the plates. These identifications are collected at the end of the text descriptive of each photograph under the heading "Identification of Stars," etc., where, in the last column:

R means right side
L means left side
T means top
B means bottom

Where a star is not bright or well known, the number in the Bonn or Cordoba Durchmusterung is assigned it, and the position given for 1855.0 or 1875.0. Some of the nebulæ are also thus identified, the number assigned to the object having been taken from Dreyer's *New General Catalogue of Nebulæ and Clusters of Stars* or from his *Index Catalogues.*

In like manner the smaller defects that have occurred in the reproduction are (when necessary to avoid mistakes) located in a similar way.

It has been thought unnecessary to thus identify the stars in the comet photographs, for, having fewer stars to deal with, the difficulty of their identification is not so marked. From the position of the head and the approximate position angle of the tail, the location of the comet on the charts is very easily determined.

In the present work, the stand has been taken that there exist in space masses of more or less opaque matter, nearer to us in general than the stars, whose presence, in the form of partially luminous "nebulosity," is shown by the scarcity or entire absence of stars which seem to be blotted out by it in certain parts of the sky. These probable obscuring masses are apparently more frequent in the Milky Way, where, perhaps, the great number of stars more readily indicates their presence. The belief in the existence of this obscuring matter is not based alone on the photographs contained in this volume, though they gave rise to it. It has been strengthened and, to me made a fact, by the study of the later and more perfect photographs (more perfect because of the larger scale) which were made by me with the Bruce telescope of the Yerkes Observatory in the past eight or ten years, and especially of those made by me with the same telescope on Mount Wilson, California, in the summer of 1905. A photographic search has been made in recent years with this instrument for these apparently vacant or nebulous regions, with the hope of accumulating as much information as possible as to their extent and distribution. The most remarkable of these singular features seem to be in the southern region of the Milky Way in **Ophiuchus** and **Scorpio**, though some striking cases are found in **Taurus** and **Cepheus.**

It is possible that later discoveries made on some of the photographs of the Milky Way included in this volume may render it desirable to know the exact times when the plates were taken. All of the exposure times are, therefore, printed here. In the case of the comet photographs, the exposure times will be found in the descriptions accompanying the plates.

LIST OF EXPOSURE TIMES OF STAR PLATES

Plate No.	P. S. T.	Duration of Exposure.	Plate No.	P. S. T.	Duration of Exposure.	Plate No.	P. S. T.	Duration of Exposure.	Plate No.	P S T.	Duration of Exposure.
	h m	h m		h m	h m		h m	h m		h m	h m
2	8 30	1 47	24	14 35	4 10	46	10 38	3 5	68	11 34	2 13
3	9 52	1 30	25	16 2	1 25	47	10 38	3 5	69	11 50	5 10
4	10 5	2 50	26	9 25	3 16	48	13 22	2 15	70	9 14	4 43
5	16 25	2 0	27	9 25	3 16	49	9 38	3 0	71	8 50	4 20
6	15 48	3 15	28	9 10	3 0	50	9 38	3 0	72	8 58	2 35
7	8 40	3 0	29	8 6	2 28	51	12 40	3 30	73	11 10	3 0
8	10 45	4 10	30	14 45	0 30	52	12 40	3 30	74	9 17	5 0
9	8 50	5 0	31	15 47	2 0	53	9 40	1 20	75	10 0	4 0
10	14 34	2 0	32	9 29	2 0	54	11 0	4 10	76	13 4	4 17
11	14 8	3 15	33	12 30	1 0	55	11 40	4 30	77	10 44	3 15
12	10 47	3 0	34	10 48	4 0	56	12 55	3 0	78	11 2	6 5
13	8 35	4 0	35	10 40	3 20	57	11 48	4 25	79	10 45	5 20
14	14 44	0 20	36	11 12	4 0	58	11 48	4 25	80	10 45	5 20
15	8 30	5 0		10 50	3 30	59	8 46	3 5	81	13 38	4 15
	8 28	5 15	37	10 32	1 55	60	10 42	4 30	82	11 50	7 0
16	11 50	6 0	38	11 18	3 35	61	14 30	2 21	83	11 54	5 0
17	11 50	6 0	39	11 55	4 0	62	. . . .	4 30	84	11 52	6 21
18	10 42	2 0	40	11 18	3 35	63	. . . .	4 30	85	13 55	6 0
19	12 50	4 20	41	11 0	3 0	64	11 0	5 10	86	11 10	4 20
20	14 0	2 0	42	12 12	4 5	65	13 28	3 20	87	14 55	4 0
21	13 0	3 0	43	12 12	4 5	66	11 8	5 30	88	15 25	3 0
22	11 55	2 10	44	11 20	4 0	67	11 18	4 5	89	14 12	3 5
23	11 55	2 10	45	10 30	2 51						

I would beg to express my heartiest thanks and appreciation to Professor R. G. Aitken, who has kindly compared and checked all the proofs of this volume with the manuscript.

E. E. BARNARD.

Yerkes Observatory,
Williams Bay, Wisconsin,
December 16, 1913.

THE

PHOTOGRAPHS

PLATE 1

THE MOON WITH A PORTRAIT LENS

(Top is north)

1895 February 26 1895 August 17

1895 June 25 (Venus and the Moon) 1895 September 3 (Total Eclipse of the Moon)

The details are not so sharp in the reproduction as in the originals, in which much detail, both on the eclipsed and earth-lit Moons, is quite clearly shown. In the photograph of *Venus* and the Moon the glow in the crescent is due to halation.

7—L

PLATE 2

IN CASSIOPEIA—NEAR κ CASSIOPEIÆ

(Top is north) (Scale: 1 cm. = 37′.6)
1855.0 α $0^h\ 32^m$ δ + 62°.9
1894 February 6 Exposure $1^h\ 47^m$

The two small fan-shaped nebulæ close north and east of γ **Cassiopeiæ** are well shown. They point towards the star in each case. The ring of light around γ itself is due to halation, and is not real.

The arrangement of the stars in cloud forms is not so well marked as in the original picture, but they indicate fairly well the peculiarity of the Milky Way in this region.

On the original negative the 9.5 magnitude star BD + 64° 13 (1855.0, $0^h\ 5^m\ 39^s$ + 64° 48′.4) is in the center of a small irregular nebulosity 2′ — 3′ in diameter. It is not in Dreyer's lists.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In.	mm.
β **Cassiopeiæ** . .	2.2	1855.0	0	1	29.6	+58	21.0	B	1.4	=36	R	0.8	=20
BD + 64° 13	9.5	1855.0	0	5	39	+64	48.4	T	1.6	41	R	1.58	40
κ **Cassiopeiæ** . . .	4.5	1855.0	0	24	48	+62	7.8	B	3.6	91	R	2.8	71
η **Cassiopeiæ** . . .	3.8	1855.0	0	40	21.7	+57	2.4	B	0.4	10	L	2.3	58
γ **Cassiopeiæ** . .	2.3	1855.0	0	47	59.9	+59	55.8	B	2.3	58	L	1.8	46
BD + 64° 127 . . .	5.9	1855.0	1	2	21	+64	13.3	T	1.9	48	L	1.0	25

DEFECTS

Description.	Distance from Edge of Plate.					
		In.	mm.		In.	mm.
Elongated, white (1 in. N.E. of γ) . . .	B	3.1	=79	L	0.9	=23
Small, white	T	1.57	40	R	1.55	39

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ASTOR, LENOX AND
TILDEN

PLATE 3

REGION OF THE GREAT NEBULA OF ANDROMEDA

(Top is north) (Scale: 1 cm. = 36′.9)
1855.0 α $0^h\ 42^m$ $\delta + 41^\circ.1$
1894 October 4 Exposure $1^h\ 30^m$

There is no nebulosity on this plate besides the well known nebula; any inequalities of illumination are defects of reproduction. The sky should, therefore, be uniformly dark.

Apparently the stars to the east of the nebula are, on the average, of a slightly larger size and perhaps fewer in number. Otherwise they seem to be uniformly scattered over this part of the sky.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.		Distance from Edge of Plate.					
		h m s	° ′		In.	mm.		In.	mm.
ν Andromedæ .	4.7	1855.0 0 41 51.3	+40 17.6	T	3.9	=99	L	3.7	=94
BD +44° 176 . .	6.8	1855.0 0 42 12.9	+44 12.5	T	1.35	34	L	3.65	93
μ Andromedæ .	4.2	1855.0 0 48 43.8	+37 42.7	B	2.2	56	L	2.8	71
β Andromedæ .	2.2	1855.0 1 1 37.6	+34 50.5	B	0.5	13	L	1.1	28

DEFECTS

Description.	Distance from Edge of Plate.					
		In.	mm.		In.	mm.
Small, light	T	0.9	=23	R	1.0	=25
Irregular, white	T	2.1	53	R	2.1	53
Small, luminous	B	3.7	94	R	3.6	91
Irregular, light	T	2.5	64	L	0.4	10

PLATE 4

THE GREAT NEBULA OF ANDROMEDA

(Top is north) (Scale: 1 cm. = 18′.2)
1855.0 α 0h 35m δ + 40°.9
1895 September 16 Exposure 2h 50m

The background of the plate should be uniformly dark. Three is a slight halation ring about ν **Andromedæ.**

The striking difference in the brightness of the stars BD +38° 91 of 8.0 magnitude and BD + 38° 90 of 5.5 magnitude will be noticed. On the photograph they are apparently equal.

Identification of Stars, Etc.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In.	mm.
BD + 39° 138 . . .	6.5	1855.0	0	29	39.1	+39	32.1	B	2.2	=56	R	1.4	=36
BD + 38° 90	5.5	1855.0	0	33	17.1	+38	39.0	B	1.1	28	R	2.3	58
BD + 38° 91	8.0	1855.0	0	33	21.4	+38	47.9	B	1.3	33	R	2.3	58
ν Andromedæ . .	4.7	1855.0	0	41	51.3	+40	17.6	B	3.2	81	L	0.9	23

Defects

Description.	Distance from Edge of Plate.					
		In.	mm.		In.	mm.
Small, white, irregular	B	0.8	= 20	R	0.3	= 8

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PLATE 5

IN CASSIOPEIA—NEAR γ CASSIOPEIÆ

(Top is north) (Scale: 1 cm. = 36′.2)
1855.0 α 0^h 44^m δ +60°.0
1894, November 8 Exposure 2^h 0^m

The star γ **Cassiopeiæ** occupies the middle of the plate. The two small fan-shaped nebulæ above and to the right are shown, but the immediate glow about the star is due to halation.

Considerable areas of unequal illumination appear on the plate—especially in the lower part and near the top. These are defects of reproduction—the background should be uniformly dark. There is no diffused nebulosity shown here except the small one close following, and attached to the star BD + 55° 191.

The distribution of stars in this region is unequal. There is a tendency toward massing in patches, with some indications of cloud forms.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In.	mm.
ϰ **Cassiopeiæ** . .	4.5	1855.0	0	24	48	+62	7.8	T	2.0=	51	R	2.0=	51
α **Cassiopeiæ** . .	Var.	1855.0	0	32	18.8	+55	44.6	B	1.5	38	R	2.4	61
η **Cassiopeiæ** . .	3.8	1855.0	0	40	21.7	+57	2.4	B	2.5	64	R	3.1	79
BD + 55° 191 . . .	7.7	1855.0	0	44	23.5	+55	50.2	B	1.6	41	R	3.5	89
Dreyer 281	. . .	Nebulosity about the above star											
γ **Cassiopeiæ** . .	2.3	1855.0	0	47	59.9	+59	55.8	T	3.5	89	L	3.4	86
δ **Cassiopeiæ** . .	3.0	1855.0	1	16	23.3	+59	28.6	T	3.6	91	L	1.0	25
Dreyer 457	. . .	1860.0	1	10	20	+57	35	B	2.8	71	L	1.4	36

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PLATE 6

IN CASSIOPEIA

(Top is north)　　　　(Scale: 1 cm. = 37′.7)
1855.0 α 1h 20m　　δ +65°.5
1894 November 7　　Exposure 3h 15m

No nebulosity is shown on the plate except the small patches near γ **Cassiopeiæ.** There are a few unreal luminous patches, but these are easily recognized, especially the one just above the middle of the plate and to the left. The massing of the stars in cloud forms is fairly well shown, particularly in the region of ε and γ **Cassiopeiæ.**

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In.	mm.
γ **Cassiopeiæ** . .	2.3	1855.0	0	47	59 9	+59	55.8	B	0.2 =	5	R	0.7 =	18
BD + 68° 77	6.0	1855.0	1	0	56	+68	0.2	T	1.4	36	R	2.1	53
ε **Cassiopeiæ** . . .	3.3	1855.0	1	44	4	+62	57.3	B	2.1	53	L	1.6	41
Dreyer 663	. . .	1860.0	1	36	29	+60	32.3	B	0.5	13	L	2.0	51

DEFECTS

Description.	Distance from Edge of Plate.					
		In.	mm.		In.	mm.
Light strip	T	1.4 =	36	R	2.8 =	71

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PLATE 7

IN CASSIOPEIA—NEAR δ CASSIOPEIÆ

(Top is north) (Scale: 1 cm. = 44′.4)
1855.0 α 1^h 32^m $\delta + 59°.2$
1894 February 2 Exposure 3^h 0^m

The plate is essentially free from defects.

The two small nebulæ near γ **Cassiopeiæ** are shown close to the right edge of the plate above the middle. There is no diffused nebulosity shown.

This is a region of very small stars with a sprinkling of considerably larger ones. There are several small dark spots in the brighter mass of stars near the middle, and a large irregular one to the left of ϵ **Cassiopeiæ.**

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In.	mm.
γ **Cassiopeiæ** . .	2.3	1855.0	0	47	59.9	+59	55.8	T	2.5 =	64	R	0.0 =	0
δ **Cassiopeiæ** . .	3.0	1855.0	1	16	23.3	+59	28.6	T	3.0	76	R	2.2	56
BD + 54° 396 . . .	5.7	1855.0	1	42	30.3	+54	25.7	B	0.9	23	L	2.5	64
ϵ **Cassiopeiæ** . .	3.3	1855.0	1	44	4	+62	57.3	T	0.8	20	L	2.6	66
Dreyer 457	. . .	1860.0	1	10	20	+57	35	B	2.9	74	R	1.6	41
Dreyer 663	. . .	1860.0	1	36	29	+60	32.3	T	2.4	61	L	3.1	79
Dreyer 869	. . .	1860.0	2	9	15	+56	30.1	B	2.4	61	L	0.2	5
Dreyer 884	. . .	1860.0	2	12	35	+56	28.0						

DEFECTS

Description.	Distance from Edge of Plate.					
		In	mm.		In.	mm.
Small, black	T	2.7 =	69	R	2.6 =	66
Small, black	T	2.9	74	R	3.4	86

PLATE 8

IN CASSIOPEIA—NEAR ε CASSIOPEIÆ

(Top is north) (Scale: 1 cm. = 36′.6)
1855.0 α 1^h 38^m δ + 63°.3
1895 September 14 Exposure 4^h 10^m

No diffused nebulosity appears in this region.

The cluster Dreyer 663 seems to send off straggling masses of stars to the south and west, and in other directions for at least 50 minutes, and it appears to be formed among the general mass of stars that cover a considerable area, especially to the west and southwest. The singular dark marking nearly a degree to the southwest of this cluster is fairly well shown, with some curious dark lanes near by. A similar dark spot occurs slightly west of M 103.

The double cluster of **Perseus** is visible in the lower left corner.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In.	mm.
δ Cassiopeiæ . . .	3.0	1855.0	1	16	23.3	+59	28.6	B	2.0	=51	R	1.6	=41
ε Cassiopeiæ . . .	3.3	1855.0	1	44	4	+62	57.3	T	3.8	97	L	3.3	84
BD + 66° 213 . . .	4.7	1855.0	2	17	12	+66	44.6	T	1.1	28	L	1.2	30
Dreyer 457	. . .	1860.0	1	10	20	+57	35	B	0.8	20	R	1.0	25
Dreyer 581 = M 103	. . .	1860.0	1	24	0	+59	58.5	B	2.3	58	R	2.2	56
Dreyer 663	. . .	1860.0	1	36	29	+60	32 3	B	2.6	66	R	3.2	81

PLATE 9

REGION NEAR THE DOUBLE CLUSTER OF PERSEUS

(Top is north) (Scale: 1 cm. = 46′.5)
1855.0 α 1^h 58^m δ + 57°.0
1893 November 3 Exposure 5^h 0^m

The region around the clusters H VI 33, 34 **Persei** (Dreyer 869 and 884) is curiously marked by vacancies, especially to the west. There is a clustering tendency among the stars at various points on the plate, especially about three degrees above 33 and 34, where a feeble imitation of the double cluster appears.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In.	mm.
δ Cassiopeiæ . .	3.0	1855.0	1	16	23.3	+59	28.6	T	2.1	=53	R	0.4	=10
BD + 49° 444 . . .	4.1	1855.0	1	34	36.0	+49	57.6	B	0.6	15	R	1.2	30
ε Cassiopeiæ . . .	3.3	1855.0	1	44	4	+62	57.3	T	0.4	10	R	2.4	61
Dreyer 663	. . .	1860.0	1	36	29	+60	32.3	T	1.7	43	R	1.8	46
Dreyer 869	. . .	1860.0	2	9	15	+56	30.1	T	3.8	97	L	2.3	58
Dreyer 884	. . .	1860.0	2	12	35	+56	28.0						

PLATE 10

REGION IN CETUS

(Top is north) (Scale: 1 cm. = 36′.8)
1855.0 $\alpha\ 2^h\ 8^m$ $\delta\ +8^{\circ}.2$
1895 July 24 Exposure $2^h\ 0^m$

This is one of several photographs taken in a search for Comet 1884 II, which was not found. An ephemeris is given by Berberich in *A. N.* **136**, 334, 1894. It is a region of relatively few and rather small stars. There is no diffused nebulosity shown on the plate.

Identification of Stars, Etc.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In.	mm.
α Piscium	3.5	1855.0	1	54	33.8	+2	3.7	B	0.0=	0	R	1.3=	33
BD+7° 347	6.3	1855.0	2	3	43.0	+7	53.4	T	3.7	94	R	2.8	71
BD+8° 345	4.6	1855.0	2	5	19.3	+8	9.8	T	3.5	89	R	3.0	76
BD+9° 316	5.7	1855.0	2	17	3.0	+9	57.9	T	2.4	61	L	2.2	56
BD+7° 388	4.5	1855.0	2	20	27.7	+7	48.4	T	3.7	94	L	1.6	41

PLATE 11

IN PERSEUS

Top is north) **(Scale: 1 cm. = 36′.5)**

1855.0 α 2ʰ 48ᵐ δ + 53°.2

1894 August 9 **Exposure 3ʰ 15ᵐ**

This plate was exposed for the purpose of securing trails of the Perseid meteors. One trail of a very bright and almost stationary meteor was obtained. It is shown in the upper part of the plate. This is a region of comparatively few stars. The sky in the western portion, however, is covered with great quantities of very small stars, which apparently increase in number towards the rich region near the double cluster. The clustering of bright stars southeast of Capella is very marked.

There is no diffused nebulosity on the plate and the background should be uniformly dark. The several large, diffused, luminous regions are therefore defects in the reproduction—especially to the western edge of the plate.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In.	mm.
γ **Persei**	3.2	1855.0	2	54	20.0	+52	56.0	T	4.1 =	104	L	3.1 =	79
Meteor	. . .	1855.0	2	55		+57	50	T	0.9	23	L	3.2	81
Very small cluster	. . .	1855.0	3	4	50	+46	39	B	0.5	13	L	1.8	46
α **Persei**	2.0	1855.0	3	13	59.4	+49	20.7	B	2.4	61	L	0.9	23
Dreyer 884	. . .	1860.0	2	12	35	+56	28.0	T	1.6	41	R	0.2	5

DEFECTS

Description.	Distance from Edge of Plate.					
		In.	mm.		In.	mm.
Small, irregular, light	B	4.1 =	104	L	3.0 =	76
Small, irregular, light	T	4.3	109	L	2.9	74
Small, round, light	B	3.6	91	L	0.2	5

PLATE 12

IN ERIDANUS

(Top is north) **(Scale: 1 cm = 37′.7)**
1855.0 α 3h 8m δ − 28°.9
1894 November 2 **Exposure 3h 0m**

This is one of four photographs of this region made in a search for **Brucia** (323) which was not found. An ephemeris of the planet was supplied me by Professor Lewis Boss. It is a region of few stars. There is no diffused nebulosity on the plate, and the background should be uniformly dark.

Near CD − 24° 1387 is − 24° 1388 ($9^m.9$). This star is shown on the plate 0.05 inch south and 0.05 inch east of 1387, but is very faint. It is probably red or variable. Plates on 1894, October 4 and 5 and November 6 do not show any sensible change in it.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In.	mm.
CD − 32° 1025 . . .	4.5	1875.0	2	43	51.9	− 32	56.1	B	0.9 =	23	R	0.4 =	10
CD − 24° 1387 . . .	4.1	1875.0	2	56	53.0	− 24	6.6	T	0.2	5	R	2.0	51
CD − 29° 1177 . . .	3.6	1875.0	3	6	46.3	− 29	28.7	B	3.1	79	R	3.4	86
CD − 25° 1452 . . .	6.9	1875.0	3	27	3.0	− 25	2.1	T	0.9	23	L	0.8	20

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PLATE 13

IN TAURUS

(Top is north) (Scale: 1 cm. = 35′.3)
1855.0 α 3ʰ 35ᵐ δ + 27°.0
1893 December 1 Exposure 4ʰ 0ᵐ

This reproduction is unsatisfactory and can be used only for the stars. The luminous regions near the **Pleiades** are partly unreal and must not be confused with the exterior nebulosities, which are well shown on Plate 15. The nebulosity about BD + 25° 624 is real, while those about BD + 23° 473 and below the **Pleiades** to the edge of the plate are false. There are a number of small defects, some of which are cared for in the list of defects. One of these destroys the image of BD + 22° 531.

The almost uniform bed of stars, which covers most of the plate, ends rather abruptly at a blank region (in the upper part of the picture) which extends south and west from *o* **Persei**.

A considerable meteor trail is shown near the right edge of the plate, directed toward the cluster, and passing over, or close to the stars BD + 28° 529 and + 27° 513.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In.	mm.
BD + 28° 529	9.0	1855.0	3	16	15.1	+28	12.5	T	2.5 =	64	R	0.6 =	15
BD + 27° 513	8.0	1855.0	3	22	14.2	+27	12.9	T	3.2	81	R	1.5	38
BD + 27° 514	8.0	1855.0	3	22	19.1	+27	13.2						
BD + 27° 515	5.7	1855.0	3	22	35.8	+27	3.8	T	3.3	84	R	1.5	38
BD + 23° 473	6.2	1855.0	3	25	53.2	+23	59.2	B	2.2	56	R	2.0	51
BD + 22° 531	8.7	1855.0	3	33	33.1	+22	24.8	B	1.1	28	L	3.4	86
BD + 22° 532	7.5	1855.0	3	33	44.6	+22	19.6	B	1.1	28	L	3.4	86
o **Persei**	3.8	1855.0	3	35	16.2	+31	49.6	T	0.1	3	L	3.3	84
BD + 25° 624	6.0	1855.0	3	41	35.0	+25	8.8	B	3.0	76	L	2.2	56
ζ **Persei**	3.0	1855.0	3	45	2.0	+31	27.6	T	0.3	8	L	1.9	48
Dreyer 1333	. . .	1860.0	3	20	41	+30	53.5	T	0.7	18	R	1.2	30

DEFECTS

Description.	Distance from Edge of Plate.					
		In.	mm.		In.	mm.
Irregular, light	B	1.7 =	43	R	1.0 =	25
Two irregular, light spots	B	1.2	30	R	3.2	81
Two or three irregular, light	B	1.0	25	L	2.5	64
Small, luminous	B	1.1	28	L	2.2	56
Small, irregular, light	B	0.6	15	L	0.8	20

PLATE 14

THE PLEIADES

(Top is north) (Scale: 1 cm. = 24'.5)
1855.0 α 3^h 38^m $\delta + 24^\circ.0$
1895 September 30 Exposure 0^h 20^m

The reproduction is unsatisfactory. The photograph was made in strong moonlight. It should be studied in connection with Plate 15, as it shows the stars that are missing in that photograph of the cluster. The **Merope** nebula is well shown, strongly resembling the view one gets of it in a small telescope.

PLATE 15

THE PLEIADES, SHOWING EXTERIOR NEBULOSITIES

(Top is north) (Scale: 1 cm. = 34′.2)
1855.0 α $3^h 40^m$ $\delta + 24^\circ.0$
1893 December 6–8 Exposure $10^h 15^m$

This plate, which is a successful reproduction, was made in the negative form to bring out more clearly the exterior nebulosities. The darkening at the lower right corner is unreal. With the exception of this and the darkening at the left side near the star + 21° 585 the other dark markings are real nebulosities. See *A. N.* **136**, 193, 1894.

For the individual stars of the cluster see Plate 14.

Identification of Stars, Etc.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In	mm.
BD + 23° 473	6.2	1855.0	3	25	53.2	+ 23	59.2	T	2.7 =	69	R	1.1 =	28
BD + 20° 621	6.2	1855.0	3	36	3.4	+ 20	28.0	B	0.7	18	R	2.7	69
BD + 25° 624	6.0	1855.0	3	41	35.0	+ 25	8.8	T	1.9	48	L	2.8	71
BD + 25° 641	6.6	1855.0	3	44	50.8	+ 25	14.6	T	1.8	46	L	2.3	58
BD + 21° 585	5.0	1855.0	3	56	8.3	+ 21	40.5	B	1.6	41	L	0.4	10
BD + 27° 633	5.1	1855.0	3	57	43.7	+ 27	13.6	T	0.5	13	L	0.3	8

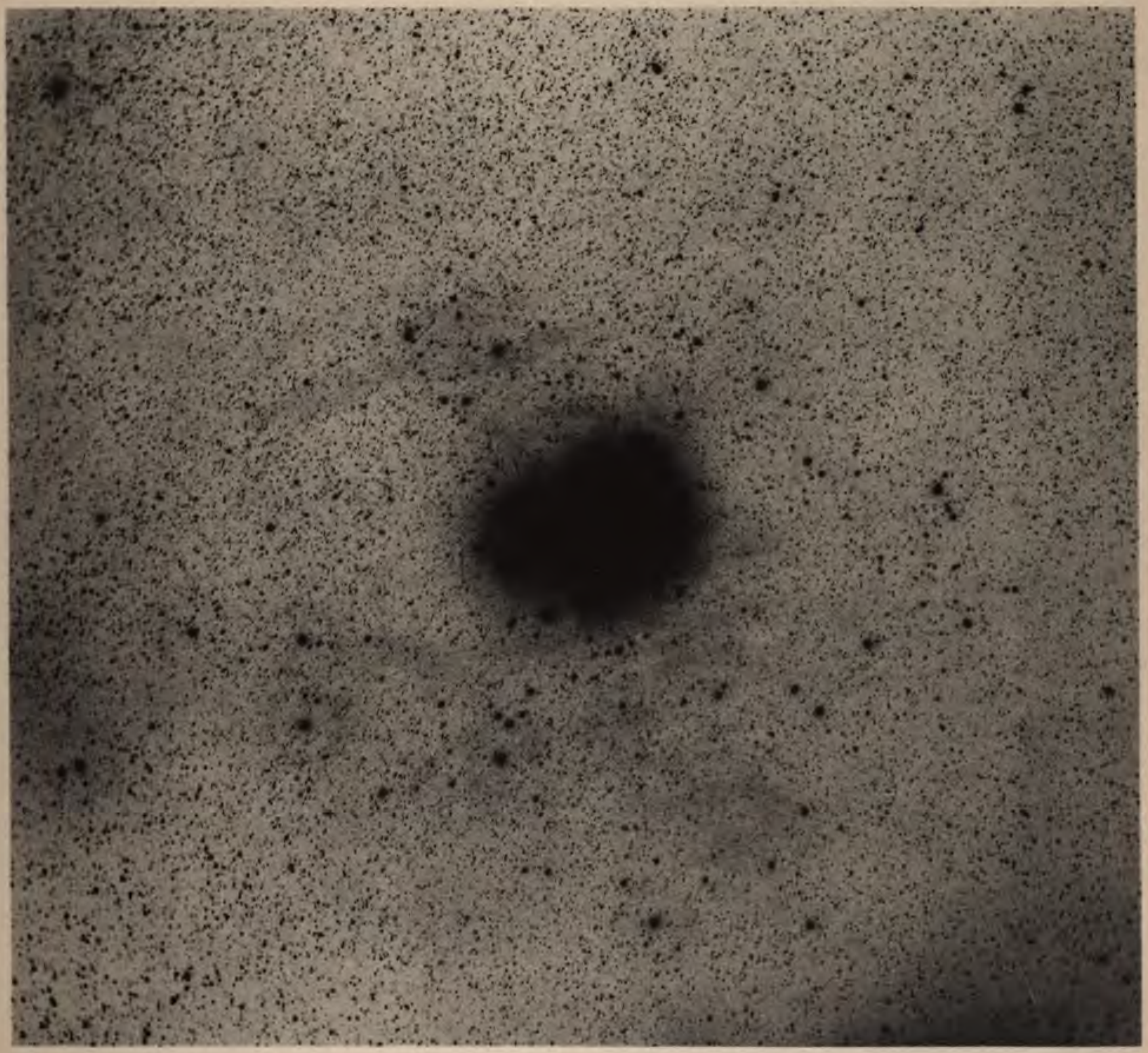

PLATE 16

IN PERSEUS—NEAR ξ PERSEI

REGION OF THE NEBULA DREYER 1499
(Top is north) (Scale: 1 cm. = 37′.4)
1855.0 α 3^h 47^m δ + 35°.9
1895 September 21 Exposure 6^h 0^m

This nebula was discovered visually by the writer on November 3, 1885, with the 6-inch telescope of the Vanderbilt University Observatory, Nashville, Tenn.

The original negative shows it to be a very remarkable object, made up of irregular, but well defined bright strips and masses. The small black spot in the nebula above the middle is real, and is either some kind of absorbing matter or a hole in the nebula. It is better shown on Plate 17. See *Ap. J.* **2**, 350, 1895. There are several small light defects above and to the right of the star BD + 36° 805, which are free from the nebula.

Attention has already been called to the vacant region in the lower right corner south of *o* **Persei**. (See Plate 13.) It is probable that faint nebulosities might be revealed in this region with very long exposures, especially as there is much diffused nebulosity about the star BD + 31° 643, close south of *o* **Persei.** But part of the luminosity about *o* is due to halation, to which cause the glow about ε and ζ is due.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In.	mm.
o **Persei**	3.8	1855.0	3	35	16.2	+31	49.6	B	2.1 =	53	R	1.6 =	41
ζ **Persei**	3.0	1855.0	3	45	2.0	+31	27.6	B	1.9	48	R	2.9	74
ε **Persei**	3.2	1855.0	3	48	9 1	+39	35.4	T	1.3	33	L	3.3	84
ξ **Persei**	4.2	1855.0	3	49	33.8	+35	22.8	T	4.0	102	L	3.1	79
BD + 36° 805	7.5	1855.0	3	51	45.0	+36	35.6	T	3.2	81	L	2.8	71

DEFECTS

Description	Distance from Edge of Plate.					
		In.	mm.		In.	mm.
Long scratch	B	2.6 =	66	R	1.5 =	38
Small, light	B	1.2	30	L	2.0	51

PLATE 17

THE NEBULA DREYER N. G. C. 1499

(Right is north) (Scale: 1 cm. = 19′.3)
1855.0 α 3h 50m δ + 36°.0
1895 September 21 Exposure 6h 0m

This is an enlargement of Plate 16 and shows the nebula to better advantage. It lies on, and partly forms, the very definite border between a rich region of stars and a very poor one.

A photograph of this nebula by Dr. Roberts (*Celestial Photographs*, by Isaac Roberts, **2**, Plate 22), shows it to be a very extraordinary object.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In.	mm.
BD + 33° 698	4.8	1855.0	3	33	13.0	+33	28.6	B	0.4 =	10	R	0.0 =	0
BD + 36° 742	5.5	1855.0	3	35	10.0	+36	0.3	T	3.0	76	R	0.5	13
ξ Persei	4.2	1855.0	3	49	33.8	+35	22.8	B	2.8	71	R	4.1	104
BD + 36° 805	7.5	1855.0	3	51	45.0	+36	35.6	T	2.2	56	L	3.5	89
BD + 37° 882	5.5	1855.0	3	58	58.0	+37	40.1	T	0.7	18	L	1.8	46

DEFECTS

Description.	Distance from Edge of Plate.					
		In.	mm.		In.	mm.
Irregular, white	T	0.8 =	20	L	3.3 =	84

PLATE 18

REGION OF THE HYADES

(Top is north) (Scale: 1 cm. = $36'.8$)
1855.0 $\alpha\ 4^h\ 23^m$ $\delta\ +17^\circ.4$
1893 December 9 Exposure $2^h\ 0^m$

There is no diffused nebulosity on this plate and the background should be uniformly dark. The luminosity about **Aldebaran** is a halation effect. In the upper left portion of the plate is the beautiful scattering cluster Dreyer 1647.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	'		In.	mm.		In.	mm.
BD + 21° 642	4.3	1855.0	4	16	44.0	+21	58.1	T	0.5	= 13	R	2.1	= 53
BD + 17° 719	4.7	1855.0	4	17	7.2	+17	35.6	T	3.2	81	R	2.2	56
Aldebaran	1.1	1855.0	4	27	36.1	+16	12.9	B	3.4	86	L	2.8	71
BD + 12° 618	4.0	1855.0	4	30	4.4	+12	13.1	B	0.9	23	L	2.4	61
Dreyer 1647	. . .	1860.0	4	37	55	+18	48.6	T	2.4	61	L	1.3	33

DEFECTS

Description.	Distance from Edge of Plate.					
		In.	mm.		In.	mm.
Trail-like	B	1.7	= 43	R	2.4	= 61
White, trail-like	B	3.8	97	R	3.8	97

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PLATE 19

REGION NEAR η AURIGÆ

(Top is north) (Scale: 1 cm. = 39′.4)
1855.0 $\alpha\ 4^h\ 52^m$ $\delta\ +40^\circ.9$
1895 September 17 Exposure $4^h\ 20^m$

There is no diffused nebulosity on this plate. The luminous region near the lower right corner is a defect.

Eta Aurigæ is in a very rich region of considerable stars, which thins out and becomes very poor in the lower right quadrant, while a similar thinning out occurs in the upper right part of the plate, above the cluster Dreyer 1664 and especially close east of the star BD+43° 1166.

Identification of Stars, Etc.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In	mm.		In.	mm.
BD+43° 1043 . . .	5.7	1855.0	4	32	37.9	+43	4.9	T	1.7	=43	R	0.4	=10
BD+37° 1005 . . .	5.7	1855.0	4	49	25.2	+37	40.2	B	2.1	53	R	2.8	71
BD+43° 1166 . . .	Var.	1855.0	4	51	34.6	+43	36.2	T	1.4	36	L	3.6	91
η **Aurigæ**	3.4	1855.0	4	56	21.2	+41	2.4	T	3.1	79	L	3.1	79
BD+38° 1063 . . .	5.2	1855.0	5	3	31.3	+38	18.3	B	2.5	64	L	2.1	53
Capella	1.0	1855.0	5	5	58.6	+45	50.6	T	0.0	0	L	2.0	51
Dreyer 1664	. . .	1860.0	4	41	2	+43	26.7	T	1.5	38	R	1.8	46
Dreyer 1912 = M 38	. . .	1860.0	5	19	17	+35	42.4	B	1.0	25	L	0.1	3

PLATE 20

REGION OF THE GREAT NEBULA OF ORION

(Top is north) (Scale: 1 cm. = 36′.2)
1855.0 α 5^h 28^m δ − 5°.0
1894 October 3 Exposure 2^h 0^m

The plate was intended to show certain features which are lost in the reproduction. It shows well, however, the clustering of small, bright stars in the region of the belt and the nebulosity about, and to the south of, ζ Orionis. It will be noticed that, though there are a number of small, bright stars near the nebula, the fainter ones, shown elsewhere over the plate, seem to have disappeared close to the nebula.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In.	mm.
Rigel	1	1855.0	5	7	33.7	−8	22.1	B	2.1 =	53	R	0.1 =	3
BD − 2° 1235	3.7	1855.0	5	17	12.1	−2	31.9	T	1.9	48	R	1.7	43
ζ Orionis	2	1855.0	5	33	26.6	−2	1.8	T	1.5	38	L	2.7	69
Saiph	2½	1855.0	5	40	53.2	−9	44.2	B	1.3	33	L	1.5	38
Dreyer 2068 = M 78	. . .	1860.0	5	39	34	−0	0.3	T	0.2	5	L	1.7	43

DEFECTS

Description.	Distance from Edge of Plate.					
		In.	mm.		In.	mm.
White, star-like	B	1.7 =	43	R	2.7 =	69
Short, white, trail-like	B	3.2	81	R	2.7	69
Small, black spot (close n. f. small star in the nebula)	B	3.95	100	R	3.25	83
Small, white, irregular	B	3.2	81	L	3.2	81
Small, white, irregular	T	3.0	76	L	1.4	36
White, star-like	B	2.5	64	L	1.4	36
Light, broken spot (close s. f. a star)	T	3.25	83	L	0.2	5

PLATE 21

REGION OF α ORIONIS

(Top is north) (Scale: 1 cm. = 37'.7)
1855.0 α 5^h 44^m δ + 8°.0
1893 October 17 Exposure 3^h 0^m

The plate has been printed too light—especially in its upper part, except the upper right corner which is too black. The luminous region south from ω **Orionis** is partly real. The western side of it from ω, south, for 2 degrees is a portion of the great curved nebula that runs over a large part of the body of **Orion.** At the 7.8 magnitude star BD + 2° 1040, the nebula turns abruptly east for half a degree, and then runs south again beyond the limits of the print. Therefore, only a small portion of the luminosity is a defect—that part about one half a degree square and about 1 degree south and east of ω. On the original photograph, this extraordinary nebula is fairly well shown for a distance of about 7 degrees to the edge of the negative. For an account of this remarkable nebula, see *Ap. J.* **17**, 77, 1903. The defective part occurs only in a portion of the edition, where the prints were made too light.

There is a short prong of nebulosity, quite noticeable in the picture, running from the north side of ω itself.

The sky becomes very rich north of α **Orionis** and a dark, irregular lane will be seen about 1 degree west of it.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	'		In.	mm.		In.	mm.
32 Orionis	5.5	1855.0	5	23	2.0	+5	50.0	B	3.2	=81	R	0.4	=10
λ **Orionis**	3.5	1855.0	5	27	9.9	+9	49.5	T	2.3	58	R	1.1	28
ω **Orionis**	5.0	1855.0	5	31	34.0	+4	1.8	B	2.0	51	R	1.8	46
BD + 2° 1040	7.8	1855.0	5	34	45.5	+2	19.1	B	0.9	23	R	2.3	58
α **Orionis**	Var.	1855.0	5	47	20.3	+7	22.7	T	3.9	99	L	2.9	74
μ **Orionis**	5.0	1855.0	5	54	25.0	+9	38.6	T	2.5	64	L	1.8	46

DEFECTS

Description.	Distance from Edge of Plate.					
		In.	mm.		In	mm.
Light, irregular defect—like a small cluster	B	1.1	=28	R	2.6	=66
Narrow, light mark, $\overset{\text{in.}}{0.4}$ long	T	1.9	48	L	3.4	86

12—L

PLATE 22

IN GEMINI—NEAR M 35

(Top is north) (Scale: 1 cm = 37′.7)

1855.0 $\alpha\ 6^h\ 6^m$ $\delta + 25^\circ.0$

1894 February 1 Exposure $2^h\ 10^m$

From the immediate region of M 35 a large cloud of very small stars extends to the north and west, occupying the upper right quadrant of the plate. In some of the prints the upper part of this cloud is too luminous—a defect which has occurred in the reproduction, due to light printing, but which need deceive no one. A less dense region covers the east half of the picture. The upper parts of these two regions are separated by a darker wedge-shaped space.

M 35 appears to cover at least one degree of the sky with its scattered outliers. Though the cluster is made up in general of larger stars than occur here, which would suggest that its apparent connection with the Milky Way was accidental, one gets the impression that it is really connected with this part of the Milky Way.

The 7.7 magnitude star + 20° 1284 is apparently in the center of the nebula Dreyer 2174, but this may be an effect of projection. The nebula itself has much detail in it which is not shown in the reproduction.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In	mm.		In.	mm.
BD + 25° 1052 . . .	5.2	1855.0	5	49	0.4	+ 25	55.8	T	2.9	= 74	R	1.1	= 28
BD + 20° 1284 . . .	7.7	1855.0	6	1	2.1	+ 20	30.8	B	1.5	38	R	2.8	71
Dreyer 2174		Involving the above star											
ν Geminorum . .	4.3	1855.0	6	20	22.2	+ 20	18.2	B	1.4	36	L	1.4	36
Dreyer 2168 = M 35	. . .	1860.0	6	0	13	+ 24	20.7	T	3.9	99	R	2.8	71

PLATE 23

IN GEMINI—REGION OF M 35 (ENLARGED)

(Top is north) (Scale: 1 cm. = 24′.5)
1855.0 $\alpha\ 6^h\ 0^m$ $\delta + 24\frac{1}{2}^\circ$
1894 February 1 Exposure $2^h\ 10^m$

This is an excellent reproduction and is free of defects. It shows more clearly than Plate 22 the probable connection of the cluster with the Milky Way.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In.	mm.
BD + 25° 1052 . . .	5.2	1855.0	5	49	0.4	+25	55.8	T	1.8	=46	R	0.6	=15
η Geminorum . .	3.0	1855.0	6	14	13.4	+22	34.8	B	2.7	69	L	0.4	10
Dreyer 2168 = M 35	. . .	1860.0	6	0	13	+24	20.7	T	3.5	89	R	3.0	76

PLATE 24

IN ORION

(Top is north) (Scale: 1 cm. = 37′.2)

1855.0 $\alpha\ 6^h\ 4^m$ $\delta + 12°.0$

1893 October 12 Exposure $4^h\ 10^m$

The luminosity about and south of α **Orionis** is not real. That along the left edge of the plate is also unreal and destroys the effect of some of the dark regions. The prints have been made too light.

This part of the sky is rich in small stars, with a scattering of brighter ones. Some dark spaces occur near α **Orionis.** Near the left edge of the plate is a dark channel which runs north and south for 1½ degrees or more and somewhat resembles the one north and west of α **Orionis.**

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm		In.	mm.
α **Orionis**	Var.	1855.0	5	47	20.3	+ 7	22.7	B	1.5=	38	R	0.9=	23
BD + 14° 1152 . . .	4.6	1855.0	5	59	17.9	+ 19	46.9	T	2.4	61	R	2.8	71
Dreyer 2194	. . .	1860.0	6	5	55	+ 12	50.5	T	3.7	94	L	3.1	79
Dreyer 2245	. . .	1860.0	6	24	58	+ 10	15.5	B	3.2	81	L	0.3	8

PLATE 25

IN ORION

(Top is north)   (Scale: 1 cm.=36′.8)
1855.0 α 6h 6m δ +15°.5
1893 October 11   Exposure 1h 25m

The small stars assume more or less of cloud forms to the west and north of γ **Geminorum.** The longer exposure of Plate 24, shows the dark structures better. As an illustration, in Plate 24 three degrees above the nebula Dreyer 2245, near the left edge of the plate, is an irregular, fairly well defined dark lane. This does not appear in the present plate, because not enough faint stars are shown to reveal its outlines. At the same time, the general structure that does not depend on very small stars, is well shown.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In.	mm.
BD+14° 1152 . . .	4.6	1855.0	5	59	17.9	+14	46.9	B	3.8=	97	R	2.5=	64
ν **Geminorum** . .	4.6	1855.0	6	20	22.2	+20	18.2	T	0.6	15	L	1.7	43
γ **Geminorum** . .	2.1	1855.0	6	29	21.4	+16	31.3	T	3.0	76	L	0.2	5
Dreyer 2174	. . .	1860.0	6	1	3	+20	41.0	T	0.5	13	R	2.8	71
Dreyer 2195? . . .	. . .	1860.0	6	6	12	+17	41.0	T	2.1	53	R	3.3	84
Dreyer 2245	. . .	1860.0	6	24	58	+10	15.5	B	0.7	18	L	1.0	25

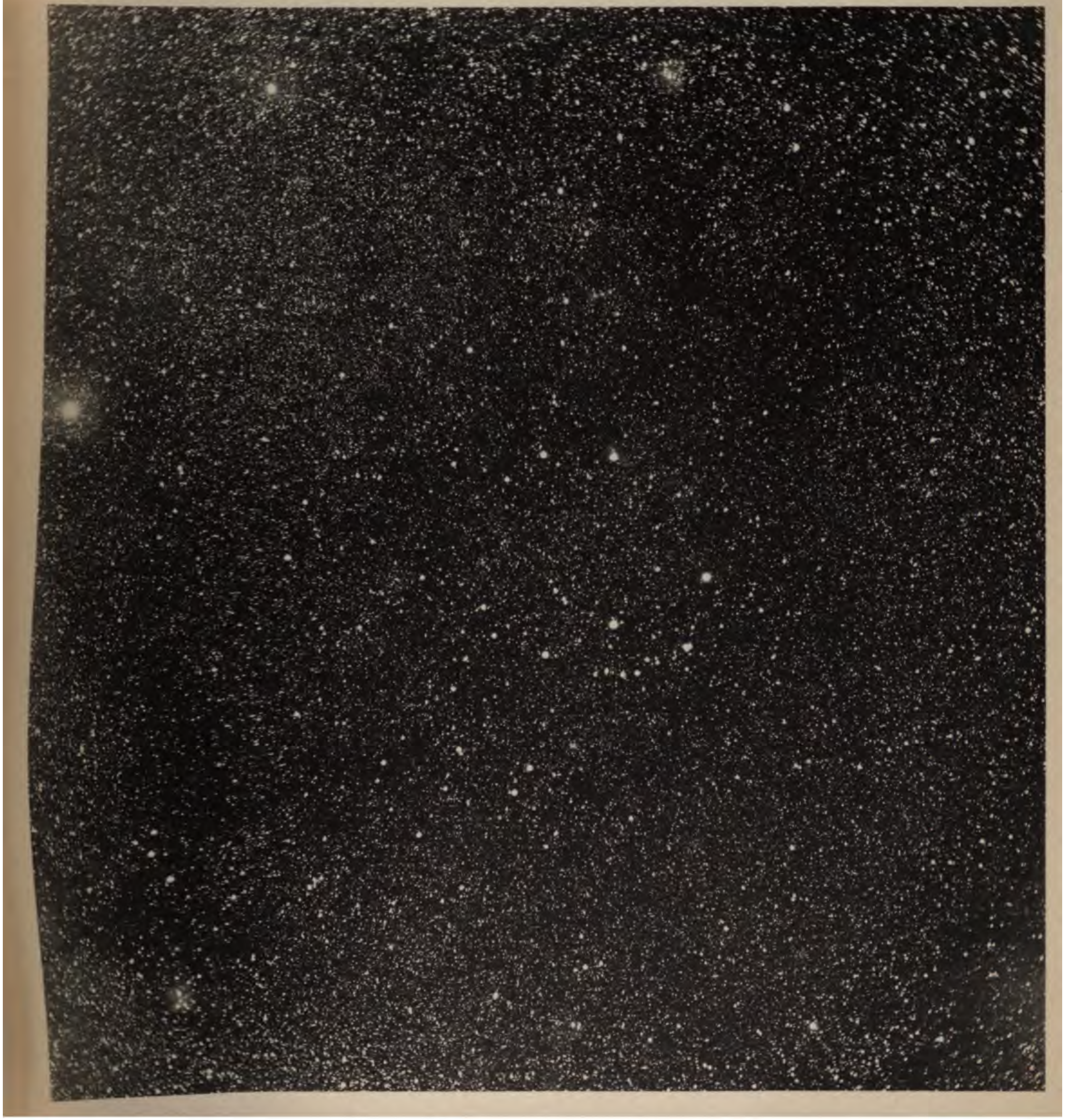

PLATE 26

IN MONOCEROS—NEAR DREYER N. G. C. 2237

(Top is north) (Scale: 1 cm. = 37′.1)
1855.0 α $6^h\ 22^m$ δ $+5^\circ.0$
1894 January 11 Exposure $3^h\ 16^m$

The nebula Dreyer 2237 is well shown with its cluster of small bright stars. This is a region of small stars in which occur many curious dark lanes, especially in the center and near the left and below. There is a straight line of small equal stars 1¼ degrees to the east of the nebula, running nearly north and south and some 20 minutes long that looks almost like a defect on the plate. Other lines of stars, especially long curved lines, are readily picked out. There is a peculiar and irregular dark region 3½ degrees to the east of the nebula.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate,					
			h	m	s	°	′		In.	mm.		In.	mm.
15 Monocerotis .	4.0	1855.0	6	33	0.2	+10	1.8	T	0.6=	15	L	1.9=	48
Dreyer 2237	. . .	1860.0	6	22	51	+ 5	8.5	T	3.7	94	L	3.3	84
Dreyer 2245	. . .	1860.0	6	24	58	+10	15.5	T	0.6	15	L	3.5	89

PLATE 27

REGION OF THE NEBULA DREYER N. G. C. 2237 (ENLARGED)

(Top is north)   (Scale: 1 cm. = 15′.0)
1855.0 α 6^{h} 22^{m} δ $+5^{\circ}.0$
1894 January 11   Exposure 3^{h} 16^{m}

This is an enlargement from Plate 26 and shows well the nebula and its immediate surroundings.

Though there are a number of curious condensations in the nebulosity, one feature brought out by the plate (and one which often occurs) is that in no case does the nebulosity condense about the stars that apparently are in it. This nebulosity is readily seen in a telescope, but it has the appearance of a broken ring about the cluster, the real darkness of the interior portion being accentuated in visual observations by the presence of the bright stars. (See *A. N.* **122**, 253, 1889.)

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In.	mm.
BD+4° 1236	4.9	1855.0	6	16	4.3	+4	39.9	B	3.6	=91	R	0.1=	3
BD+7° 1337	5.0	1855.0	6	25	3.7	+7	26.3	T	0.3	8	L	2.8	71
BD+5° 1334	7.0	1855.0	6	30	11.0	+5	4.8	B	4.0	102	L	0.9	23

PLATE 28

THE NEBULOUS REGION OF 15 MONOCEROTIS

(Top is north) (Scale: 1 cm. = 23′.6)
1855.0 α 6^h 30^m δ +10°.0
1894 February 1 Exposure 3^h 0^m

This is a beautiful reproduction. It clearly shows the extended nebulosity about 15 **Monocerotis** and the small nebula Dreyer 2245.. Near the middle of this latter nebula there are one or two very well defined small black holes.

The diffused nebulosity about 15 **Monocerotis** is very remarkable. It is readily traced for nearly two degrees north and south. There is much detail in it near the brighter stars, one short curved mass being specially noticeable above the brighter portion. Strong indications of an extension of the fainter nebulosity can be traced to still greater distances south and east. Above the nebula Dreyer 2245, is the nebulous star Dreyer *Index Catalog* 446. The nebula Dreyer *Index Catalog* 447 should be struck out of the catalog. It is Dreyer 2245 with a wrong position given by me.

The great, nearly vacant region, beginning near the nebula and running for 2 or 3 degrees to the west, and then turning north for even a greater distance, is beautifully shown.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In.	mm.
13 **Monocerotis** .	5.0	1855.0	6	25	3.7	+ 7	26.3	B	2.0 =	51	R	1.8 =	46
15 **Monocerotis** .	4.0	1855.0	6	33	0.2	+10	1.8	T	3.6	91	L	2.6	66
ζ **Geminorum** . . .	3.7	1855.0	6	37	9.6	+13	2.7	T	0.6	15	L	1.6	41
Dreyer Index Catalog 446	. . .	1860.0	6	23	14	+10	32.6	T	3.2	81	R	1.2	30
Dreyer 2245	. . .	1860.0	6	24	58	+10	15.5	T	3.7	94	R	1.2	30

PLATE 29

IN GEMINI—SOUTH OF γ GEMINORUM

(Top is north) (Scale: 1 cm. = 37′.1)
1855.0 α 6ʰ 34ᵐ δ + 13°.0
1894 January 24 Exposure 2ʰ 28ᵐ

Though not so brilliant and striking as Plate 28, this photograph gives a better idea of the real structure of the sky in this region. Notwithstanding the fact that the exposure is over half an hour shorter than that of Plate 28, the nebulosities about 15 **Monocerotis** are distinctly shown and the structure of the dark region is better brought out by apparently a considerable increase of faint stars. These fainter stars, which just elude Plate 28, have materially changed the outlines of the great vacancy in several respects—especially in the region 4 degrees to the northwest of 15 **Monocerotis**, where dark zigzag lanes now appear. It must be understood that the successful reproduction of a faint nebulosity is quite a different problem from that of faint stars, as in the present case, where the nebulosity is better shown in Plate 28, and the general structure of the sky in Plate 29. The showing of the nebulosity in such a photograph is a matter of transparency of the sky, while that of the faint stars is a matter of definition.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In.	mm.
BD + 7° 1337	5.0	1855.0	6	25	3.7	+ 7	26.3	B	0.6 =	15	R	2.0 =	51
γ Geminorum . .	2	1855.0	6	29	21.4	+ 16	31.3	T	1.8	46	R	2.8	71
15 **Monocerotis** .	4.0	1855.0	6	33	0.2	+ 10	1.8	B	2.3	58	R	3.3	84
ζ Geminorum . .	3.7	1855.0	6	37	9.6	+ 13	2.7	T	4.0	102	L	3.1	79
BD + 16° 1298 . . .	6.5	1855.0	6	41	29.6	+ 16	22.1	T	1.9	48	L	2.5	64
BD + 13° 1462 . . .	5.3	1855.0	6	46	27.7	+ 13	21.8	B	4.4	112	L	1.7	43
Dreyer 2245	. . .	1860.0	6	24	58	+ 10	15.5	B	2.3	58	R	1.7	43

PLATE 30

IN CANIS MAJOR—SOUTH OF SIRIUS (NEAR M 41)

(Top is north) (Scale: 1 cm. = 37′.1)
1855.0 α $6^h\ 38^m$ δ −20°.5
1894 October 4 Exposure $0^h\ 30^m$

Most of the stars in M 41, near the center of the plate, are larger than the average in this region, which might give the impression that they are not a condensation from the general background of small stars here. The star CD—23° 3991 is surrounded by a thin clustering of small stars that look suspiciously as if they belong to it.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In.	mm.
β Canis Majoris .	3	1855.0	6	16	18.9	−17	53.2	T	2.0=	51	R	0.1=	3
Sirius	1	1855.0	6	38	44.6	−16	31.6	T	1.0	25	R	3.5	89
CD−23° 3991 . . .	4.5	1875.0	6	26	39.1	−23	19.9	B	2.4	61	R	1.6	41
δ Canis Majoris .	2.1	1875.0	7	3	19.0	−26	12.0	B	0.5	13	L	0.3	8
Dreyer 2287 = M 41	. . .	1860.0	6	41	0	−20	36.0	T	3.6	91	R	3.7	94

PLATE 31

IN MONOCEROS

(Top is north) (Scale: 1 cm. = 36′.2)

1855.0 α 6^h 46^m δ $-3°.2$

1895 September 24 Exposure 2^h 0^m

The luminous places near the right edge of the plate and near the bottom are unreal.

There is considerable structure in the form of vacant lanes, especially near the left side of the plate where the stars are very small and thickly strewn. Apparently there are fewer stars and larger ones near the middle, but this may be due to the plate having possibly been slightly within the focal plane.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.			
			h	m	s	°	′		In. mm.		In. mm.
BD − 2° 1776	6.1	1855.0	6	41	58.2	−2	6.6	T	2.5=64	R	2.0=51
BD − 4° 1788	5.0	1855.0	6	55	42.9	−4	2.0	B	3.0 76	L	1.7 43
Dreyer 2301	. . .	1860.0	6	44	35	+0	32.7	T	0.7 18	R	2.4 61
Dreyer 2323 = M 50	. . .	1860.0	6	56	13	−8	8.8	B	0.3 8	L	1.6 41

DEFECTS

Description.	Distance from Edge of Plate.			
		In. mm.		In. mm.
Long, white scratch	B	1.8=46	L	0.5=13

PLATE 32

IN GEMINI—NEAR CASTOR AND POLLUX

(Top is north) (Scale: 1 cm. = 36′.9)
1855.0 α 7^h 25^m δ +32°.2
1895 April 16 Exposure 2^h 0^m

There is not much of interest in this plate. But there are narrow vacant lanes in the region of **Castor** to the west and northwest, and a curious straggling line of slightly brighter stars passing just above **Castor** from the left to the right and inclining downwards to the west for a distance of 4 or 5 degrees. This is a rather curious feature when the eye once catches it. If the plate is held at a large angle to the vertical and looked at from the right side, the string of stars becomes quite noticeable as a sinuous curve which passes just south of ρ **Geminorum.**

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In.	mm.
BD+32° 1562 . . .	5.0	1855.0	7	19	47.1	+32	4.2	B	3.4	=86	R	2.4	=61
Castor	1.7	1855.0	7	25	20.7	+32	11.9	B	3.5	89	L	3.0	76
Pollux	1.3	1855.0	7	36	26.9	+28	22.2	B	1.0	25	L	1.4	36

DEFECTS

Description.	Distance from Edge of Plate.					
		In.	mm.		In.	mm.
Large, light spot	T	0.6	=15	L	.32	=58
Large, light spot	B	0.8	20	L	1.9	48
Small, luminous spot	T	2.9	74	L	0.8	20

PLATE 33

REGION OF PRÆSEPE IN CANCER

(Top is north) (Scale: 1 cm. = 37′.1)
1855.0 α 8^{h} 35^{m} δ +20°.7
1893 December 15 Exposure 1^{h} 0^{m}

The background of the sky here is sprinkled over with relatively few stars, against which the cluster is well shown. One gets the impression that Præsepe does not consist only of the few bright stars, for there are perhaps a few more small stars in it than the average in this part of the sky.

The large luminosity toward the upper right corner is unreal. There are no diffused nebulosities on the plate.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In.	mm.
BD + 21° 1895 . .	4.5	1855.0	8	34	54.1	+21	59.4	T	3.2 =	81	L	3.6 =	91
BD + 18° 2027 . .	4.5	1855.0	8	36	26.6	+18	41.5	B	3.2	81	L	3.4	86
BD + 15° 1945 . .	5.7	1855.0	8	49	9.9	+15	52.5	B	1.5	38	L	1.4	36
Dreyer 2632 = M 44	. . .	1860.0	8	32		+20	28	B	4.1	104	R	3.3	84

DEFECTS

Description.	Distance from Edge of Plate.					
		In.	mm.		In.	mm.
Small, black spot	T	4.0 =	102	R	3.4 =	86
Short, light, trail-like	T	3.3	84	L	1.8	46

PLATE 34

REGION OF COMA BERENICES

(Top is north) (Scale: 1 cm. = 37′.7)
1855.0 α 12^h 14^m δ +27°.3
1894 March 9 Exposure 4^h 0^m

Apparently there are no nebulosities connected with the stars of this group, though it is a region rich in nebulæ. The slender ray to the left of the middle is Dreyer 4565. The slight inequalities of illumination of the background are unreal.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In.	mm.
BD + 24° 2443 . . .	5.3	1855.0	12	9	1.4	+24	46.9	B	2.8 =	71	R	2.8 =	71
BD + 29° 2275 . . .	5.8	1855.0	12	10	14.0	+29	45.2	T	2.4	61	R	3.0	76
BD + 23° 2475 . . .	4.8	1855.0	12	27	37.4	+23	25.9	B	2.0	51	L	1.5	38
Dreyer 4555	. . .	1860.0	12	28	43	+27	17.7	T	3.0	76	L	1.5	38
Dreyer 4565	. . .	1860.0	12	29	24	+26	45.5	B	4.1	104	L	1.4	36

DEFECTS

Description.	Distance from Edge of Plate.					
		In.	mm.		In.	mm
Large, light, irregular spot	B	4.3 =	109	R	0.7 =	18
Short scratch	B	2.4	61	R	2.6	66
Small, white defects about a star	B	2.5	64	R	3.2	81
Small, light, irregular spot	T	2.8	71	R	3.4	86
Two small, white spots	B	3.2	81	R	3.5	89
Small, light, irregular	T	1.3	33	L	3.5	89
Large, light, irregular	T	1.1	28	L	2.3	58
Luminosity near two small stars (other patches near)	T	3.7	94	L	1.7	43
Small, light, irregular	B	4.2	107	L	0.7	18
Small, light, irregular	B	3.6	91	L	0.4	10

PLATE 35

NEAR β SCORPII

(Top is north)   (Scale: 1 cm. = 37′.1)
1855.0 α 15^h 54^m δ = 18°.1
1895 May 23   Exposure 3^h 20^m

Several diffused luminous defects have occurred in the reproduction in the upper half of the plate and to the left of δ **Scorpii.** The bright illumination about β and δ is due to halation, while that close about ν is partly halation, but the main portion is due to real nebulosity about this star, which extends to the north and the west as a great wing for 1½ degrees. A similar region of nebulosity to the south and east of the star is lost in the reproduction. (See the upper right corner of Plate 36). In the original negative this nebulosity extends to the east, to the stars BD —19° 4357, 4359 and 4361, where it strongly condenses about the last two, with a thin, dark line close to them on the northeast side. The other star (— 19° 4357) is connected with these two by a thin nebulous strip, and is also involved in the nebulosity from ν **Scorpii.** In the lower left corner are the masses of nebulosity that constitute the great nebula of ρ **Ophiuchi.** In the original negative feeble traces of the great nebula that extends from δ to π **Scorpii** (*Ap. J.* **23,** 144, 1906), are shown, but they are lost in the reproduction.

In the *Astrophysical Journal*, Vol. 31, for 1910, January, I have given an account of this extraordinary region with photographs and a map showing the remarkable nebulosities. In that paper attention is called to the fact that the nebulosity of ν **Scorpii** actually cuts off the light of the stars behind it, and that it must, therefore, be nearer to us than the small stars of this region. In the Introduction (page 18) attention is called to a small patch of stars that is evidently a portion of the general background of the sky here, seen through a hole in the nebula. This spot is located in the identification list below.

This remarkable nebula was discovered with the 1½-inch lantern lens.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In.	mm.
BD - 13° 4302 . . .	5.0	1855.0	15	50	5.4	- 13	51.5	T	0.4 =	10	R	3.0 =	76
β Scorpii	2	1855.0	15	56	59.9	- 19	24.3	B	3.7	94	L	3.4	86
BD - 18° 4240 . . .	7.5	1855.0	16	0	39.1	- 18	36.4	T	3.5	89	L	2.8	71
BD - 17° 4502 . . .	6.5	1855.0	16	1	34.4	- 17	57.1	T	3.1	79	L	2.7	69
ν Scorpii	4.5	1855.0	16	3	33.9	- 19	4.4	B	4.0	102	L	2.4	61
BD - 17° 4511 . . .	7.3	1855.0	16	3	40.6	- 17	51.0	T	3.0	76	L	2.4	61
BD - 18° 4249 . . .	6.5	1855.0	16	6	17.7	- 18	9.4	T	3.2	81	L	1.9	48
Stars in hole in nebulosity . . .	. . .	1855.0	16	10		- 19	15	B	3.8	97	L	1.4	36
BD - 19° 4357 . . .	6.0	1855.0	16	10	38.3	- 19	51.5	B	3.4	86	L	1.3	33
BD - 19° 4359 . . .	7.7	1855.0	16	11	36.3	- 19	41.9	B	3.5	89	L	1.1	28
BD - 19° 4361 . . .	7.3	1855.0	16	12	0.8	- 19	45.7						
δ Scorpii	2.7	1875.0	15	52	57.1	- 22	16.2	B	2.0	51	L	4.1	104
ρ Ophiuchi	4.8	1875.0	16	18	6.1	- 23	9.2	B	1.3	33	L	0.4	10

PLATE 36

REGION OF THE GREAT NEBULA OF ρ OPHIUCHI

(Top is north) (Scale: 1 cm. = 44′.6)
1855.0 α 16^h 20^m δ −24°.2
1895 June 21–22 Exposure 7^h 30^m

I do not think there is any other region of the heavens so extraordinary as this, about, and in the immediate vicinity of, ρ **Ophiuchi.** One hesitates at any attempt to describe it. Perhaps even more remarkable than the nebulosities are the vacant lanes that run eastward from the great nebula, and those in the upper part of the plate. The considerable dark space 2 degrees northeast of τ **Scorpii** is unreal.

To begin with, the glow about **Antares** and τ **Scorpii** is due to halation as is also a portion of that about σ **Scorpii.** But a large part of the nebulosity about σ is real; it extends toward and joins the great nebula about ρ **Ophiuchi.** In the upper right corner is ν **Scorpii** and its singular nebulosity which is so poorly shown in Plate 35.

For a better description of this region, reference should be made to the Introduction (page 19) of this work. It is only necessary to say that this remarkable region was discovered with the Willard lens, though I had found indications of nebulosity here many years before in my comet seeking.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In.	mm.
ν **Scorpii**	4.5	1855.0	16	3	33.9	−19	4.4	T	0.7	=18	R	0.8	=20
σ **Scorpii**	3.4	1875.0	16	13	37.2	−25	17.1	B	3.6	91	R	2.1	53
ρ **Ophiuchi**	4.8	1875.0	16	18	6.1	−23	9.2	T	2.8	71	R	2.6	66
Antares	1.4	1875.0	16	21	46.0	−26	8.9	B	3.2	81	R	3.1	79
τ **Scorpii**	3.2	1875.0	16	28	6.8	−27	57.2	B	2.2	56	R	3.9	99
Dreyer 6121 = M4 .	. . .	1860.0	16	15	4	−26	11.2	B	3.1	79	R	2.4	61

DEFECTS

Description.	Distance from Edge of Plate.					
		In.	mm.		In.	mm.
Light, curved	B	3.0	=76	R	2.2	=56

PLATE 37

IN SCORPIO—NEAR ε AND μ SCORPII

(Top is north) (Scale: 1 cm. = 37′.4)

1855.0 α 16^h 36^m δ − 35°.2

1895 June 12 Exposure 1^h 55^m

This plate, though in part defective, is full of interest. The irregular illumination along the right side of the plate is unreal. With the exception of the definite dark region in the upper right corner (which is also a defect) this would deceive no one. The luminous spot 1½ degrees to the east of Dreyer 6124 is a defect, as is also the light spot three inches from the bottom on the left side. There are a few other minor defects which are taken care of in the usual tabulation. The glow about μ and about ε **Scorpii** is due to halation.

The patchy condition of the Milky Way in the upper left quadrant is real and very striking. The faint star CD — 34° 11418 ($9^m.8$) is in one of the black patchy holes. A little more than half way from ε **Scorpii** to the top of the plate is a curious horseshoe shaped figure of small stars with a brighter one near the middle.

The coarse cluster in 16^h 48^m, — 40°.3 does not seem to be in Dreyer's lists. It is a very interesting object and appears to be connected by a scattering chain of stars, with the cluster Dreyer 6231 south of it. In its northern part is the nebula Dreyer *2d Index Catalog* 4628. This was originally discovered on a plate with the Willard lens, but no announcement was made of it. It is a large nebula one half degree in diameter and of irregular form and brightness. A photograph with the 10-inch Bruce telescope at Mount Wilson in 1905 (June 21) shows the irregular group of stars and the nebula very beautifully. There are still fainter portions that extend half a degree to the northeast. The nebulosity, apparently, does not condense about any one of the stars and is probably not actually connected with the cluster.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate					
			h	m	s	°	′		In.	mm.		In.	mm.
CD − 34° 11044 . . .	4.6	1875.0	16	23	13.6	− 34	25.7	T	3.1 =	79	R	1.3 =	33
ε **Scorpii**	2.3	1875.0	16	42	3.4	− 34	3.3	T	2.8	71	L	2.7	69
μ' **Scorpii**	3.6	1875.0	16	43	24.6	− 37	49.7	B	2.8	71	L	2.6	66
CD − 34° 11418 . . .	9.8	1875.0	16	54	42.5	− 34	12.3	T	3.0	76	L	1.1	28
Very small black hole	. . .	1875.0	16	55		− 33	5	T	3.0	76	L	1.0	25
Dreyer 6124	. . .	1860.0	16	16	1	− 40	20.1	B	1.2	30	R	0.6	15
Dreyer 6231	. . .	1860.0	16	44	15	− 41	33.6	B	0.4	10	L	2.5	64
Dreyer 6242	. . .	1860.0	16	46	4	− 39	16.2	B	1.9	48	L	2.2	56
Dreyer 2nd Index Catalog 4628 . .	. . .	1860.0	16	46	44	− 40	14	B	1.2	30	L	2.1	53

DEFECTS

Description.	Distance from Edge of Plate.					
		In.	mm.		In.	mm.
Light, elongated	B	0.4 =	10	R	0.2 =	5
White, like a hazy star	B	3.9	99	L	0.5	13
Light, irregular.	T	0.6	15	L	0.5	13
Light, irregular	T	2.3	58	L	0.1	3

PLATE 38

REGION OF θ OPHIUCHI

(Top is north) (Scale: 1 cm. = 44′.1)
1855.0 α 17^h 11^m δ −25°.3
1894 July 6 Exposure 3^h 35^m

This photograph shows the extraordinary region of θ **Ophiuchi.**

There are a few defects of illumination along the right edge of the plate. These are readily distinguished from the real structure. Unfortunately, the reproduction, though otherwise a good one, is flat, and relatively dull. Of course, the halation ring about θ will not deceive any one. The extreme top portion of the plate is darker than it should be, due mainly to defective illumination, giving the impression of a vacant region which is not real. The dark markings on the plate, otherwise, are real.

Splendid half-tone reproductions of this region with the 10-inch Bruce telescope of the Yerkes Observatory will be found in *Pop. Astron.* **14**, 579, 1906. The main features of this region are, perhaps, better shown in Plate 39.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.			Distance from Edge of Plate.	
			h m s	° ′	In. mm.	In. mm.
58 Ophiuchi . . .	5.2	1855.0	17 34 45.0	−21 36.1	T 1.4=36	L 0.1= 3
θ Ophiuchi	3.6	1875.0	17 14 20.5	−24 52.3	T 3.1 79	L 2.8 71

DEFECTS

Description.	Distance from Edge of Plate.	
	In. mm.	In. mm.
Small, grey	T 2.8=71	R 2.6=66

PLATE 39

REGION NORTH OF θ OPHIUCHI

(Top is north) (Scale: 1 cm. = 46′.5)
1855.0 α 17^{h} 12^{m} δ −21°.3
1892 June 25 Exposure 4^{h} 0^{m}

This reproduction, which is harsher than that of Plate 38, shows the remarkable structures of the sky near and north of θ very strikingly. There is a small S shaped black marking with several other minute black spots near it, something less than 2 degrees north of θ. The beautiful details of these and others of the dark structures are very satisfactorily reproduced. The great vacancy to the southeast of θ, which runs west under that star, is too near the edge of the plate to be well shown. The mass of stars in the lower right corner is too harsh and is badly reproduced. This latter region is better shown in Plate 38.

A line of considerable stars will be noticed running diagonally from near the upper left corner for about 4 degrees. This becomes more noticeable if one inclines the plate and looks along the line. The dark region at the upper right corner is not altogether real.

To the left is a region of remarkable cloud forms, in the middle of which is placed the star 58 **Ophiuchi**. These are better shown in Plates 42, 43 and 44.

The region 3 or 4 degrees north of θ, photographed with the Bruce 10-inch telescope of the Yerkes Observatory, shows very extraordinary details in some of the larger structures seen on this plate.

A long white line-like defect will be noticed about half an inch above the star CD −23° 13412.

Identification of Stars, Etc.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm		In.	mm.
η Ophiuchi	2	1855.0	17	2	4.0	−15	32.2	T	0.3 =	8	R	1.9 =	48
ξ Ophiuchi	5.0	1855.0	17	12	19.2	−20	57.3	T	3.2	81	R	3.2	81
58 **Ophiuchi** . . .	5.2	1855.0	17	34	45.0	−21	36.1	T	3.6	91	L	0.4	10
θ Ophiuchi	3.6	1875.0	17	14	20.5	−24	52.3	B	2.2	56	L	3.1	79
CD − 24° 13337 . . .	4.5	1875.0	17	18	44.5	−24	2.9	B	2.6	66	L	2.6	66
CD − 23° 13412 . . .	5.2	1875.0	17	23	47.8	−23	52.1	B	2.7	69	L	2.0	51
CD − 26° 12152 . . .	6.2	1875.0	17	23	59.1	−26	10.3	B	1.5	38	L	1.9	48

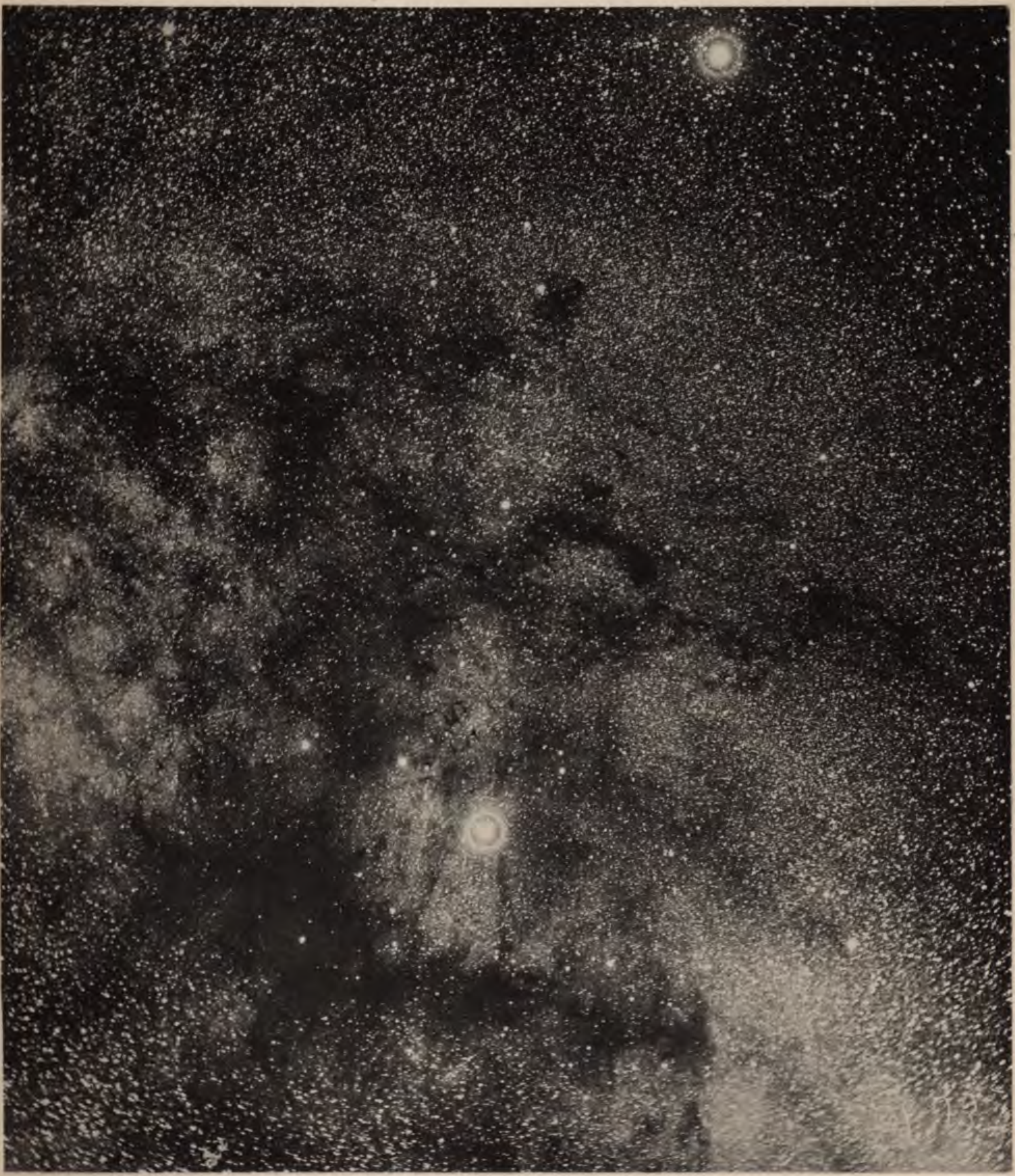

PLATE 40

REGION OF θ OPHIUCHI (ENLARGED)

(Top is north) (Scale: 1 cm.=24′.4)
1855.0 α 17^h 14^m δ $-24^{\circ}.5$
1894 July 6 Exposure 3^h 35^m

This enlargement shows the immediate region of θ **Ophiuchi** well, though the structural details are not so well brought out in the upper part of the plate as they are in Plate 39.

The great vacancy and the rift to the east and south of θ **Ophiuchi** are well shown.

Immediately above θ (about 36 minutes north) is a small, complete circle (6′ ± in diameter) of small stars. The great rift under θ is seen to be bridged either by stars too thickly clustered and too faint to be shown separately, or by nebulous matter. The bright star in the large vacancy to the southeast of θ is CD — 26° 12152 of the 6.2 magnitude.

No one will be deceived by the halation ring about θ and CD — 24° 13337.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In.	mm.
BD - 21° 4544 . . .	6.8	1855.0	17	3	59.3	- 21	25.7	T	1.4=	36	R	1.4=	36
ξ Ophiuchi	5.0	1855.0	17	12	19.2	- 20	57.3	T	0.9	23	R	3.3	84
CD - 27° 11516 . . .	6.3	1875.0	17	4	35.6	- 27	36.1	B	1.4	36	R	1.4	36
CD - 26° 12026 . . .	4.9	1875.0	17	7	40.2	- 26	25.1	B	2.5	64	R	2.0	51
CD - 24° 13255 . . .	5.5	1875.0	17	10	23.9	- 24	8.4	T	4.0	102	R	2.6	66
θ Ophiuchi	3.6	1875.0	17	14	20.5	- 24	52.3	B	4.0	102	L	3.3	84
CD - 24° 13337 . . .	4.5	1875.0	17	18	44.5	- 24	2.9	T	3.9	99	L	2.3	58
CD - 23° 13412 . . .	5.2	1875.0	17	23	47.8	- 23	52.1	T	3.8	97	L	1.1	28
CD - 26° 12152 . . .	6.2	1875.0	17	23	59.1	- 26	10.3	B	2.8	71	L	1.2	30

DEFECTS

Description.	Distance from Edge of Plate.					
		In.	mm.		In.	mm.
Two white, irregular spots	T	2.8=	71	L	2.5=	64
Small, white, irregular	B	2.4	61	L	1.0	25
Small, grey, elongated	B	3.2	81	L	0.5	13
Small, white, irregular	B	2.9	74	L	0.3	8

PLATE 41

NEAR ξ SERPENTIS

(Top is north) (Scale: 1 cm. = 37′.4)
1855.0 α 17^h 28^m δ $-15^\circ.0$
1895 July 19 Exposure 3^h 0^m

Near the bottom of the plate are some of the cloudy masses in the region of 58 **Ophiuchi** which are better shown in Plates 42, 43 and 44. The cluster M9 on the north edge of the black hole, near the lower right corner, appears like a bright star.

The top edge of the plate, especially at the right corner, is too dark.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.			Distance from Edge of Plate.					
			h m s	° ′		In.	mm.		In.	mm.
ν **Serpentis** . . .	4.5	1855.0	17 12 39.8	−12 41.4	T	2.3=	58	R	1.0=	25
ξ **Serpentis**	3.8	1855.0	17 29 17.1	−15 18.1	T	4.0	102	L	3.2	81
ο **Serpentis**	4.5	1855.0	17 33 15.5	−12 47.6	T	2.4	61	L	2.6	66
Scattering cluster .	. . .	1855.0	17 42 . .	−11 50	T	1.8	46	L	1.2	30
Dreyer 6333 = M 9 .	. . .	1860.0	17 11 0	−18 21.9	B	2.0	51	R	0.7	18
Dreyer 6494 = M 23	. . .	1860.0	17 48 41	−18 59.7	B	1.5	38	L	0.4	10

PLATE 42

REGION OF 58 OPHIUCHI

(Top is north) (Scale: 1 cm. = 36′.8)
1855.0 α 17^h 34^m δ − 21°.3
1895 June 26 Exposure 4^h 5^m

The star near the center is 58 **Ophiuchi.** The very singular mass of irregular clouds that occupies the middle of the plate looks strange or out of place. It is quite unique in the milky way and does not give the impression of being clouds either of stars or of nebulous matter in its general makeup. In some respects these clouds have the appearance of being quite separate from the background of small stars, as if the masses were nearer to us. One would hesitate in passing on these as to their being nebulous, and yet the appearance does not suggest star masses. If, however, we examine the two small tufts at the left of the general mass, it will be seen that they are clearly made up of small stars which spread out in a scattering manner to the southeast from both masses, almost like coarse dust. This stellar resolution is not so evident in the other masses to the west.

The beautiful cluster M 23 is shown in the upper left part of the plate and the nebula M 8, and the **Trifid,** are near the lower left side. **Theta Ophiuchi** is near the lower right corner. The star 2½ degrees southeast of θ **Ophiuchi** in the large, dark space is CD — 23° 12152 (6^m.2). There is a small star-like defect close south following it. This is a good reproduction.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place			Distance from Edge of Plate.					
			h m s	° ′		In	mm.		In.	mm.
58 **Ophiuchi**	5.2	1855.0	17 34 45.0	− 21 36.1	T	3.6 =	91	L	3.4 =	86
BD − 18° 4686 . . .	6.0	1855.0	17 47 23.2	− 18 46.3	T	1.8	46	L	1.4	36
θ **Ophiuchi**	3.6	1875.0	17 14 20.5	− 24 52.3	B	2.1	53	R	0.3	8
CD − 23° 13412 . . .	5.2	1875.0	17 23 47.8	− 23 52.1	B	2.8	71	R	1.7	43
CD − 26° 12152 . . .	6.2	1875.0	17 23 59.1	− 26 10.3	B	1.3	33	R	1.8	46
Dreyer 6494 = M 23	. . .	1860.0	17 48 41	− 18 59.7	T	1.9	48	L	1.2	30
Dreyer 6514 = M 20 = **Trifid** Nebula	. . .	1860.0	17 53 54	− 23 1.5	B	3.2	81	L	0.5	13
Dreyer 6523 = M 8 .	. . .	1860.0	17 55 6	− 24 22.8	B	2.4	61	L	0.3	8

DEFECTS

Description.	Distance from Edge of Plate.					
		In.	mm.		In.	mm.
Small, white spot below bright star . . .	B	1.2 =	30	R	1.8 =	46

PLATE 43

REGION OF 58 OPHIUCHI (ENLARGED)

(Top is north) (Scale: 1 cm. = 24′.9)
1855.0 α $17^h 36^m$ δ −20°.9
1895 June 26 Exposure $4^h 5^m$

This is an enlargement of Plate 42, and shows the singular cloud-like structures perhaps better than that plate. It leaves us more in doubt, perhaps, as to the proper interpretation of what these cloud forms really are than the smaller plates. Below the middle is the trail of the asteroid **Euterpe** (27).

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.			Distance from Edge of Plate.					
			h m s	° ′		In.	mm.		In.	mm.
58 Ophiuchi . . .	5.2	1855.0	17 34 45.0	−21 36.1	B	4.1	= 104	R	3.1	= 79
BD −18° 4686 . . .	6.0	1855.0	17 47 23.2	−18 46.3	T	1.9	48	L	0.8	20
CD −23° 13412 . . .	5.2	1875.0	17 23 47.8	−23 52.1	B	1.8	46	R	0.5	13
Asteroid	. . .	1875.0	17 35 20	−23 9	B	2.65	67	R	3.1	79
Dreyer 6494 = M 23	. . .	1860.0	17 48 51	−18 59.7	T	2.1	53	L	0.6	15

PLATE 44

REGION OF 58 OPHIUCHI AND M8

(Top is north) (Scale: 1 cm. = 36′.8)
1855.0 α $17^h 41^m$ δ $-21^\circ.7$
1894 July 5 Exposure $4^h 0^m$

The reproduction is somewhat defective. At the lower right corner and up the right side, for nearly half way, the print is too light and vague. The small, dark region just east of the star CD — 23° 13412 is too much accentuated and too dark. The defective portion is better shown on Plate 42, which is excellent. With the exception just stated, the rest of the present plate is good, especially in the upper part near the cluster M 23, where the structure is better shown than in Plate 42.

One degree and a half east of the bright nebula M 8 is a beautiful group of nebulous stars which are connected with M 8 by faint but definite nebulosity (*A. N.* **180**, 233, 1892). A photograph made with the 10-inch Bruce telescope of the Yerkes Observatory in 1905 (see *A. N.* **177**, 231, 1908) shown the region and the connecting nebulosity very clearly. The identification of these nebulous stars is given in connection with Plate 52.

IDENTIFICATION OF STARS, ETC.

Object.	Mag	Place.			Distance from Edge of Plate.					
			h m s	° ′		In.	mm.		In.	mm.
58 Ophiuchi	5.2	1855.0	17 34 45.0	−21 36.1	T	3.2	=81	R	2.4	=61
BD − 18° 4686	6.0	1855.0	17 47 23.2	−18 46.3	T	1.4	36	L	2.3	58
BD − 17° 9457	9.5	1855.0	17 47 26.8	−17 9.3	T	0.6	15	L	2.0	51
CD − 23° 13412	5.2	1875.0	17 23 47.8	−23 52.1	B	2.4	61	R	0.6	15
CD − 26° 12152	6.2	1875.0	17 23 59.1	−26 10 3	B	0.9	23	R	0.6	15
Group of nebulous stars. See Plate 52	. . .	1875.0	18 2	−23 50	B	2.3	58	L	0.3	8
Dreyer 6494 = M 23	. . .	1860.0	17 48 51	−18 59.7	T	1.5	38	L	2.1	53
Dreyer 6514 = M 20 = Trifid Nebula	. . .	1860.0	17 53 54	−23 1.5	B	3.0	76	L	1.4	36
Dreyer 6523 = M 8	. . .	1860.0	17 55 6	−24 22.8	B	2.0	51	L	1.2	30

DEFECTS

Description.	Distance from Edge of Plate.					
		In.	mm.		In.	mm.
Large, dark	B	2.2	=56	R	1.2	=30

PLATE 45

WESTERN EDGE OF THE GREAT STAR CLOUDS IN SAGITTARIUS

(Top is north) (Scale: 1 cm. = 43′.7)
1855.0 α 17^h 35^m δ −30°.0
1894 June 28 Exposure 2^h 51^m

Some of the stars have short tails to them, due to the sudden stopping of the driving clock. The immediate region of θ **Ophiuchi** in the upper right corner is somewhat too hazy and nebulous looking. Otherwise the reproduction is an excellent one.

The western edge of the great star clouds is beautifully shown. When examined carefully, the great spray of stars to the left of the middle. and on the edge of the great star cloud takes on, to the fanciful eye, the form of some huge feline monster crouching, ready to spring from an eminence on to some object below. The catlike head, with mouth, nose, eyes and ears is well shown. The mass of stars north of the head represents well the crouching body of the weird beast, while the two nebulous ropes running up from the eastern side of the head seem to hold the creature in leash. So remarkable and unique is this appearance in a celestial object that I am sure one will be pardoned for calling attention to it here.

The dark region east of θ **Ophiuchi** is well shown near the upper right corner of the plate. The bright star cloud in the lower part of the plate, with a cluster of small, bright stars in it, is a remarkable object and is also well shown.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In.	mm.
θ **Ophiuchi**	3.6	1875.0	17	14	20.5	−24	52.3	T	0.7=	18	R	0.4	=10
λ **Scorpii**	2.0	1875.0	17	25	7.8	37	0.2	B	0.7	18	R	1.9	48
CD −31 14609	5.5	1875.0	17	41	3.8	−31	40.0	B	3.6	91	L	2.9	74
Center of "beast's head"	. . .	1875.0	17	44½		−29	50	T	3.5	89	L	2.3	58
Small, black hole	. . .	1875.0	17	55½		−27	50	T	2.4	61	L	1.15	29
CD −30° 15215	2.8	1875.0	17	57	47.4	−30	25.2	B	4.2	107	L	0.9	23
Dreyer 6405 M 6 . . .	. . .	1860.0	17	30	56	−32	7.1	B	3.4	86	R	2.6	66
Dreyer 6451	. . .	1860.0	17	41	41	−30	10.2	T	3.6	91	L	2.7	69
Dreyer 6475 M 7	. .	1860.0	17	44	46	−34	46.6	B	2.0	51	L	2.4	61
Dreyer 6523 M 8	.	1860.0	17	55	6	24	22.8	T	0.5	13	L	0.9	23

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PLATE 46

IN SCORPIO—NORTHEAST OF λ SCORPII

(Top is north) (Scale: 1 cm. = 38′.5)

1855.0 α $17^h\ 37^m$ δ $-34°.6$

1894 June 26 Exposure $3^h\ 5^m$

This is the same region shown in the lower part of Plate 45. The cloud mass and the group of bright stars, apparently superposed on it, are better shown, however, in the present picture. A great amount of detail appears to exist in this cloud and its immediate surroundings.

The star CD − 32° 13686 of the 9.8 magnitude occupies the middle of a rather sharply defined, irregular black spot in the upper left quadrant. This spot, with its star for an eye, has been called the "parrot's head," the "bill" or "beak" being at the lower left side.

The glow about λ **Scorpii** is due to halation. Some faint, unreal inequality of illumination, that should deceive no one, extends from the upper right side of the plate to below M 6.

IDENTIFICATION OF STARS, ETC.

Object	Mag.	Place.			Distance from Edge of Plate.			
			h m s	° ′		In. mm.		In. mm.
λ **Scorpii**	2.0	1875.0	17 25 7.8	−37 0.2	B	2.9=74	R	1.8=46
κ **Scorpii**	2.6	1875.0	17 33 51.2	−38 57.5	B	1.6 41	R	2.9 74
CD − 32° 13686	9.8	1875.0	17 56 13.9	−32 6.2	T	1.8 46	L	1.2 30
Dreyer 6405 M 6 (star in hole)	. . .	1860.0	17 30 56	−32 7.1	T	1.6 41	R	2.7 69
Dreyer 6475 = M 7	. . .	1860.0	17 44 40	−34 46.6	T	3.2 81	L	2.6 66

DEFECTS

Description.	Distance from Edge of Plate.			
		In. mm.		In. mm.
Like a faint cluster	B	3.2=81	R	0.9=23
Small, light, irregular	B	3.5 89	R	1.9 48
Very small, grey	B	3.7 94	R	2.1 53
Like a very small cluster	B	3.4 86	R	2.2 56
Like a very small cluster	B	2.8 71	R	2.5 64
Small, light, irregular	T	1.4 36	R	2.6 66
Small, white, irregular	B	3.7 94	L	3.2 81

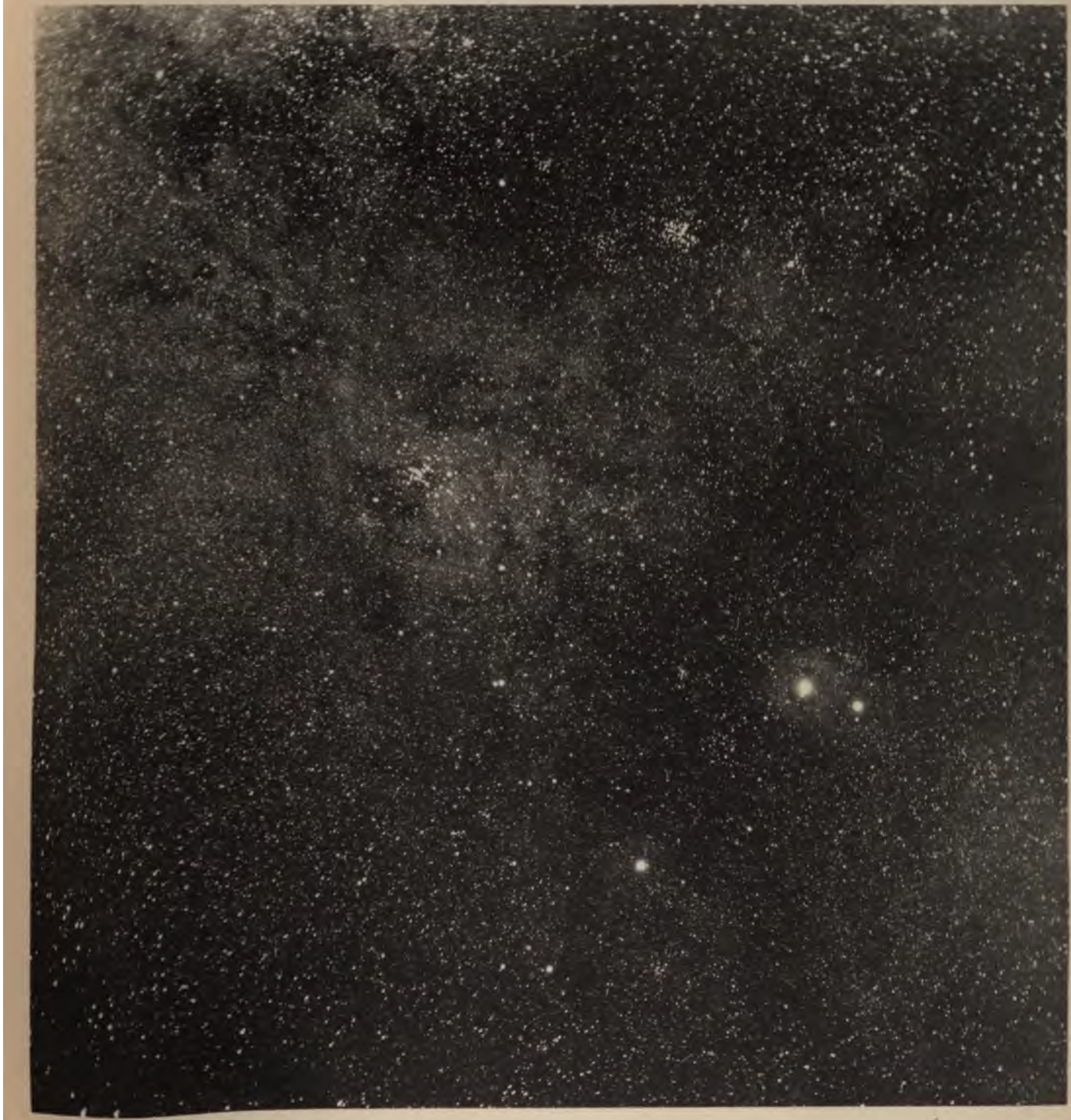

PLATE 47

STAR CLOUD IN SCORPIO (ENLARGED)

(Top is north) (Scale: 1 cm. = 24′.5)
1855.0 α 17^h 44^m δ $-34°.5$
1894 June 26 Exposure 3^h 5^m

This is a great enlargement of Plate 46. It opens out the star cloud and cluster, which are seen to be merely a projecting mass from the west side of the great star clouds, and insures a better identification of individual stars. It will be seen that the "parrot's head" near the upper left side is only a partial vacancy, as it is filled with fainter stars.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.			Distance from Edge of Plate.			
			h m s	° ′		In. mm.		In. mm.
κ Scorpii	2.6	1875.0	17 33 51.2	−38 57.5	B	0.5=13	R	1.3=33
CD −31° 14609 . . .	5.5	1875.0	17 41 3.8	−31 40 0	T	1.2 30	R	2.9 74
CD −37° 11907	3.4	1875.0	17 41 21.5	−37 0.0	B	2.4 61	R	2.8 71
CD −32° 13668 (star in hole)	9.8	1875.0	17 56 13.9	−32 6.2	T	2.1 53	L	0.9 23
Dreyer 6405 = M 6	. . .	1860.0	17 30 56	−32 7.1	T	1.7 43	R	1.0 25
Dreyer 6441	. . .	1860.0	17 40 42	−37 0.1	B	2.4 61	R	2.9 74
Dreyer 6475 = M 7	. . .	1860.0	17 44 40	−34 46.6	In the middle.			

DEFECTS

Description	Distance from Edge of Plate.			
		In. mm.		In. mm.
Small, granular	B	3.6=91	R	2.8=71

PLATE 48

IN SERPENS—NORTH OF M23

(Top is north) (Scale: 1 cm. = 37′.4)
1855.0 α 17^h 48^m δ - 15°.8
1895 June 29 Exposure 2^h 15^m

In the lower right corner is a portion of the great cloud-like masses shown in the middle of Plate 42 and also in Plate 43. A large, irregular cloud of very small stars occupies the middle of the plate. In the lower part of the cloud is a remarkable, long and conspicuous dark spot, somewhat over a degree in length, the upper part of which is larger and darker and contains a solitary star (BD — 17° 9457) of the 9.5 magnitude.

To the left, below the middle of the plate, is the small star cloud shown in Plate 54. The two lines of stars running from the direction of the right hand hole in this star cloud are very clearly shown. The south one of these can be traced for nearly 3 degrees towards the southwest. If the plate is held at a considerable angle so that one looks along the line of stars, towards the hole, it will be seen that the definiteness of the line is much enhanced. The upper part of the plate is too dark.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.			Distance from Edge of Plate.					
			h m s	° ′		In.	mm.		In.	mm.
ξ Serpentis	3.8	1855.0	17 29 17.1	- 15 18.1	T	3.6 =	91	R	0.5 =	13
ο Serpentis	4.5	1855.0	17 33 15.5	- 12 47.6	T	2.0	51	R	1.1	28
BD - 17° 9457 . . .	9.5	1855.0	17 47 28.6	- 17 9.3	B	3.2	81	R	3.5	89
BD - 9° 4632 . . .	3.8	1855.0	17 51 2.5	- 9 45.2	T	0.05	1	L	3.2	81
BD - 21° 4908 . . .	4.0	1855.0	18 5 6.1	- 21 5.2	B	0.9	23	L	1.1	28
Dreyer 6494 = M 23	. . .	1860.0	17 48 41	- 18 59.7	B	2.3	58	R	3.4	86
Dreyer 6611 = M 16	. . .	1860.0	18 10 57	- 13 50.0	T	2.8	71	L	0.1	3

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PLATE 49

GREAT STAR CLOUDS IN SAGITTARIUS

(Top is north) (Scale: 1 cm. = 37′.4)

1855.0 α $17^h\ 55^m$ δ $-27^\circ.0$

1895 August 13 Exposure $3^h\ 0^m$

These magnificent star clouds are the finest in the sky. They are full of splendid details. One necessarily fails in an attempt to describe this wonderful region of star masses. They are like the billowy clouds of a summer afternoon; strong on the side towards the Sun, and melting away into thin atmosphere on the other side. Forming abruptly at their western edge against a thinly star strewn space, these star clouds roll backwards toward the east in a broadening mass to fade away into the general sky, beyond the limits of the present picture.

In the dimmer regions, below the great bright clouds, the dark details become more interesting and delicate, especially in the region of the "parrot's head," which is a striking object.

Above the middle of the plate, in the bright star cloud is a small black spot, almost like a defect, with a small white spot close to the left of it. One and a half degrees above these, in the partially dark region, are a number of thin dark lanes running north and south. The group of nebulous stars about 1½ degrees east of M 8, and their nebulosity, are fairly well shown. The luminous region at the right edge of the plate is partly a defect of reproduction. It should be uniformly dark. The mass of clouds in the upper right corner—the same as that in the middle of Plate 42, etc.—is printed rather too light.

The first star photographs made with the Willard lens were those obtained by the writer in the early summer of 1889 of the region of the present plate (Plate 49) and of the regions of Plates 54, 62, etc. These early photographs were very wonderful, for they showed for the first time the cloud forms and general structure of the Milky Way. After the first few photographs, however, the lens was, for a long period, not available for continuing the work. Later it was refigured, and, later still, placed on the equatorial mounting of the Crocker telescope, after which the present photographs were obtained.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place			Distance from Edge of Plate.					
			h m s	° ′		In.	mm.		In.	mm.
CD − 31° 14609	5.5	1875.0	17 41 3.8	− 31 40.0	B	2.6 =	66	R	1.9 =	48
CD − 32° 13517	7.0	1875.0	17 48 6.1	− 32 26.7	B	2.1	53	R	2.9	74
CD − 32° 13529	7.2	1875.0	17 48 39.0	− 32 39.9	B	2.0	51	R	3.0	76
CD − 28° 13878	6.0	1875.0	17 48 48.0	− 28 2.6	T	3.7	94	R	2.9	74
CD − 32° 13544	8.3	1875.0	17 49 21.7	− 32 1.6	B	2.4	61	R	3.0	76
CD − 28° 13936	6.2	1875.0	17 50 43.8	− 28 45.1	T	4.2	107	R	3.2	81
Small black hole	. . .	1875.0	17 55½	− 27 50	T	3.6	91	L	3.5	89
CD − 29° 14447	6.0	1875.0	17 57 2.7	− 29 35.1	B	4.0	102	L	3.2	81
ζ **Sagittarii**	2.8	1875.0	17 57 47.4	− 30 25.2	B	3.4	86	L	3.1	79
Group of nebulous stars	. . .	(See Plate 52)			T	1.1	28	L	2.4	61
δ **Sagittarii**	2.8	1875.0	18 13 0.8	− 29 52.7	B	3.7	94	L	1.0	25
ε **Sagittarii**	1.8	1875.0	18 15 53.1	− 34 26.2	B	0.8	20	L	0.7	18
Dreyer 6514 = **Trifid** . .	. . .	1860.0	17 53 54	− 23 1.5	T	0.5	13	L	3.5	89
Dreyer 6523 = M 8 . . .	. . .	1860.0	17 55 6	− 24 22.8	T	1.4	36	L	3.2	81

DEFECTS

Description.	Distance from Edge of Plate.					
		In.	mm.		In.	mm.
Long, light, irregular	T	3.7 =	94	R	0.5 =	13
Like a small, bright cluster	T	2.4	61	R	2.2	56
Irregular scratch, like a chain of stars running to the lower edge of the plate near the right corner	B	1.3	33	R	2.8	71

PLATE 50

GREAT STAR CLOUDS IN SAGITTARIUS (ENLARGED)

(Top is north) **(Scale: 1 cm. = 24′.8)**
1855.0 α $17^h 52^m$ **δ −28°.0**
1895 August 13 **Exposure $3^h 0^m$**

This enlargement is intended to bring out the structural details of the great star clouds more clearly. In this it has been quite successful. The reproduction is excellent.

Above the middle of the plate, in the bright cloud, is a minute black hole about 6 minutes in diameter, with a small star cluster close to its east edge. (See *A. N.* **108**, 370, 1884.) This black hole is a most remarkable object in a 5-inch telescope. It looks like a drop of ink on the bright sky and its conspicuousness is strikingly enhanced by the beautiful cluster close to it.

The great ropes, apparently of nebulosity running up from the "beast's head," are well brought out. So far as I am able to judge from recent photographs with the 10-inch lens, these are really nebulous streams. The "beast's head" (see Plate 45) also somewhat resembles the head of a man, with a mustache and chin whiskers! The "parrot's head" near the bottom of the plate is a conspicuous object.

One striking fact brought out in this picture is the remarkable difference in the size of the stars composing the clouds. Those of the "head" and the plume above it are much larger and more coarsely strewn than those, say, in the eastern and southern part of the plate, while the brighter masses in the middle are also composed of relatively large stars.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.			Distance from Edge of Plate.			
			h m s	° ′		In. mm.		In. mm.
CD −31° 14609 . . .	5.5	1875.0	17 41 3.8	−31 40.0	B	1.8 = 46	R	0.4 = 10
CD −32° 13686 . . .	9.8	1875.0	17 56 13.9	−32 6.2	B	1.0 25	L	3.1 79
γ_1 **Sagittarii** . . .	6.0	1875.0	17 57 2.7	−29 35.1	B	3.8 97	L	2.8 71
γ_2 **Sagittarii** . . .	2.8	1875.0	17 57 47.4	−30 25.2	B	3.0 76	L	2.7 69
Dreyer 6451	. . .	1860.0	17 41 41	−30 10.2	B	3.2 81	R	0.7 18
Dreyer 6523 = M 8 .	. . .	1860.0	17 55 6	−24 22.8	T	0.0 0	L	2.8 71

PLATE 51

IN SAGITTARIUS—NEAR M 8

(Top is north) (Scale: 1 cm.=38′.2)
1855.0 α $17^h 56^m$ δ −23°.5
1895 June 27 Exposure $3^h\cdot 30^m$

This picture shows the region of M 8 (the large nebula near the middle of the plate) and the **Trifid** Nebula. Below these, pile up the great star clouds shown in Plate 49, while to the right and above are the fainter cloud masses in the region of 58 **Ophiuchi**.

The part of the sky shown here is a remarkable one, presenting as it does such a variety of objects and conditions. It will be noticed that the fourth magnitude star BD — 21° 4908 has an almost complete ellipse of small stars about it on its southeast side. The "beast's head" is looking over the lower edge of the plate with one of its eyes greatly enlarged.

IDENTIFICATION OF STARS, ETC.

Object	Mag.	Place.			Distance from Edge of Plate.					
			h m s	° ′		In.	mm.		In.	mm.
CD − 23° 13731	5.4	1875.0	17 52 9.9	−23 48.1	T	3.9=	99	R	3.0=	76
Dreyer 6494 = M 23	. . .	1860.0	17 48 51	−18 59.7	T	0.8	20	R	2.7	69
Dreyer 6514 = M 20 = Trifid nebula	. . .	1860.0	17 53 54	−23 1.5	B	4.8	122	L	3.7	94
Dreyer 6523 = M 8	. . .	1860.0	17 55 6	−24 22.8	B	3.8	97	L	3.5	89
Group of nebulous stars. (See Plate 52)	. . .	. . .	. . .	. . .	B	4.2	107	L	2.7	69

PLATE 52

IN SAGITTARIUS—M 8 (ENLARGED)

(Top is north) (Scale: 1 cm. = 12′.4)
1855.0 α 17^{h} 55^{m} δ $-24^{\circ}.0$
1895 June 27 Exposure 3^{h} 30^{m}

This enlargement was intended to show the structure of M8—that singular massing of stars and nebulosity—and the **Trifid** Nebula. The great reflectors of today have taken away much of the value that the enlargement might otherwise have, but it still has a supplementary value in showing the peculiarities of the region in which these nebulæ lie. About three inches to the left of M8 is a group of nebulous stars which were discovered on the Willard lens plates. (See *A. N.* **130**, 233, 1892.) Though the reproduction does not clearly show it, this group is connected directly with M8 by a diffused sheeting or band of nebulosity that extends eastward from M8 and condenses brightly about the stars in question. In its eastern edge is a definite notch or bay. The members of this group of nebulous stars I have identified in the Cordoba DM as

	m	
CD - 23° 13954	(9.2)	In faint nebulosity
- 24° 13962	(7.8)	In widely diffused nebulosity
- 23° 13983	(9.6)	Small, dense nebulosity
- 23° 13997	(8.9)	In dense nebulosity
- 23° 13998	(8.7)	
- 23° 13999	(9.6)	
- 23° 14002	(9.6)	
- 23° 14004	(9.6)	
- 23° 14005	(8.5)	In dense nebulosity
- 24° 13990	(9.7)	Dense, irregular nebulosity
- 23° 14017	(8.6)	Dense nebulosity

The star CD — 23° 13908 (8^{m}.3) is also in a small elongated nebulosity.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In.	mm.
CD - 23° 13731	5.4	1875.0	17	52	9.2	- 23	48.1	T	3.1 =	79	R	1.2 =	30
CD 24° 13749	8.7	1875.0	17	53	22.7	- 24	7.9	T	3.9	99	R	1.7	43
CD - 23° 13908	8.3	1875.0	17	58	55.8	- 23	57.4	T	3.5	89	L	2.2	56
CD - 23° 13954	9.2	1875 0	18	0	43.0	- 23	26.7	T	2.5	64	L	1.4	36
CD - 24° 13962	7.8	1875.0	18	1	39.3	- 24	0.9	T	3.7	94	L	1.0	25
CD - 23° 13983	9.6	1875.0	18	1	48.1	- 23	31.6	T	2.5	64	L	1.0	25
CD - 23° 13991	8.2	1875 0	18	1	59.1	- 23	35.0	T	2.8	71	L	0.8	20
CD - 23° 13997	8.9	1875.0	18	2	8.4	- 23	42.3	T	3.0	76	L	0.7	18
CD - 23° 13998	8.7	1875.0	18	2	9.8	- 23	40 0						
CD - 23° 13999	9.6	1875.0	18	2	11.0	- 23	40.2						
CD - 23° 14002	9.6	1875.0	18	2	14.5	- 23	37.7						
CD - 23° 14004	9.6	1875.0	18	2	26.0	- 23	39.3						
CD - 23° 14005	8.5	1875.0	18	2	29.7	- 23	47.7	T	3.2	81	L	0.6	15
CD - 24° 13990	9.7	1875.0	18	2	36.2	- 24	1.9	T	3.9	99	L	0.7	18
CD - 23° 14017	8 6	1875.0	18	2	54.6	- 23	56.4	T	3.6	91	L	0.4	10
Dreyer 6514 = M 20 = **Trifid nebula**	. . .	1860.0	17	53	54	- 23	1.5	T	1.5	38	R	2.5	64
Dreyer 6523 = M 8 . . .	. . .	1860.0	17	55	6	- 20	22 8	B	3.7	94	R	3.2	81

PLATE 53

IN OPHIUCHUS—NEAR M 87

(Top is north) (Scale: 1 cm. = 35′.6)
1855.0 α 17h 58m δ +3°.2
1894 August 24 Exposure 1h 20m

The lower half of the picture seems to show a rather poor region, while the upper part is rich in very small stars, in which curious star lines and dark lanes occur.

There are some inequalities of illumination in the lower left quadrant that are not real, but these are not likely to deceive any one. There are no diffused nebulosities on the plate.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.			Distance from Edge of Plate.					
			h m s	° ′		In.	mm.		In.	mm.
BD+2° 3403	3.5	1855.0	17 40 37.4	+2 45.2	B	3.8	=97	R	0.1	= 3
BD+4° 3570	5.3	1855.0	17 53 5.9	+4 22.1	T	2.7	69	R	2.2	56
BD+2° 3458	4.0	1855.0	17 53 23.4	+2 55.4	B	3.9	99	R	2.2	56
BD+1° 3560	4.5	1855.0	17 54 24.2	+1 18.7	B	2.8	71	R	2.4	61
BD+5° 3704	6.9	1855.0	18 14 21.9	+5 22.5	T	2.0	51	L	0.7	18

DEFECTS

Description.	Distance from Edge of Plate.					
		In	mm.		In.	mm.
Short, trail-like, white mark	B	2.6	=66	R	2.7	=69

PLATE 54

SMALL STAR CLOUD AND BLACK HOLES IN SAGITTARIUS

(Top is north) (Scale: 1 cm. = 36′.5)

1855.0 $\alpha\ 18^{h}\ 4^{m}$ $\delta\ -18^{\circ}.0$

1895 July 24 Exposure $4^{h}\ 10^{m}$

This is one of the most beautiful regions of the Milky Way. The reproduction is a very successful one.

Of the many objects that adorn this plate and make it interesting, the most striking is the remarkable star cloud that occupies the middle of the picture, in which are placed two definite black holes, the western one being the best defined. In this hole, a little to the left of the center, is a small star with a faint companion close to the west, which can be seen with a slight magnification. From these holes, to the lower right, are two diverging semi-vacant lanes, between which, at a distance of one degree from the hole, runs a sharp horizontal line, like a defect. This line is made up of a number of small bright stars close together. At its left end is a short projection of stars to the south. Above the end is the star BD — 18° 4845. The south one of these dark lanes continues for over a degree and then widens out into a dark region. The western end of this lane is continued by a fine thread of small stars—like beads on a string—for a distance of nearly 3 degrees. To the right of this string of stars is a shorter row which, if prolonged, would meet the other in the black hole, and which extends nearly as far as the first one. From the upper part of the western hole a string of brighter stars runs for a distance of over one degree in about position angle 230 degrees. A line of fainter stars continues from this toward the east. In this region are a number of other lines of stars, which, on close inspection, will readily be made out. Just below the star cloud, in the semi-vacant region, is the star BD — 19° 4953 of the 7.6 magnitude, which is involved in a dense nebulosity (*A. N.* **180**, 233, 1892). It is the brightest of a group of nebulous stars (see Plate 55). The sheeting of clouds running abruptly from the southwest edge of the star cloud, and whose east edge is so abrupt, is filled with nebulosity which covers a large area here (see *A. N.* **177**, 231, 1908). Near the right edge of the plate is the cluster M 23, and above it will be seen the long dark marking with a small bright star in its upper end.

The plate is quite free from defects of any kind, so that the differences of light and shade are correctly represented.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.			Distance from Edge of Plate.			
			h m s	° ′	In.	mm.	In.	mm.
Group of nebulous stars (See Plate 52)	. . .	. . .	. . .	. . .	B 0.6 =	15	R 2.8 =	71
BD - 21° 4908	4.0	1855.0	18 5 6.1	- 21 5.2	B 2.4	61	L 3.2	81
BD - 18° 4845	8.2	1855.0	18 5 23.0	- 18 47.8	B 3.95	100	R 3.35	85
BD - 19° 4953	7.6	1855.0	18 9 5.6	- 19 42.8	B 3.3	84	L 2.6	66
Dreyer 6494 M 23 . . .	. . .	1860.0	17 48 41	- 18 59.7	B 3.8	97	R 0.7	18
Dreyer 6514 = M 20 **Trifid** nebula	. . .	1860.0	17 53 54	- 23 1.5	B 1.2	30	R 1.7	43
Dreyer 6523 = M 8	. . .	1860.0	17 55 6	- 24 22.8	B 0.3	8	R 1.9	48
Dreyer 6611 = M 16 . . .	. . .	1860.0	18 10 57	- 13 50.0	T 0.4	10	L 2.4	61
Dreyer 6618 = M 17 . . .	. . .	1860.0	18 12 42	- 16 13.9	T 1.9	48	L 2.0	51
Dreyer *2d Index Catalog* 4745	. . .	1860.0	18 23 26	- 19 20	B 3.7	94	L 0.4	10

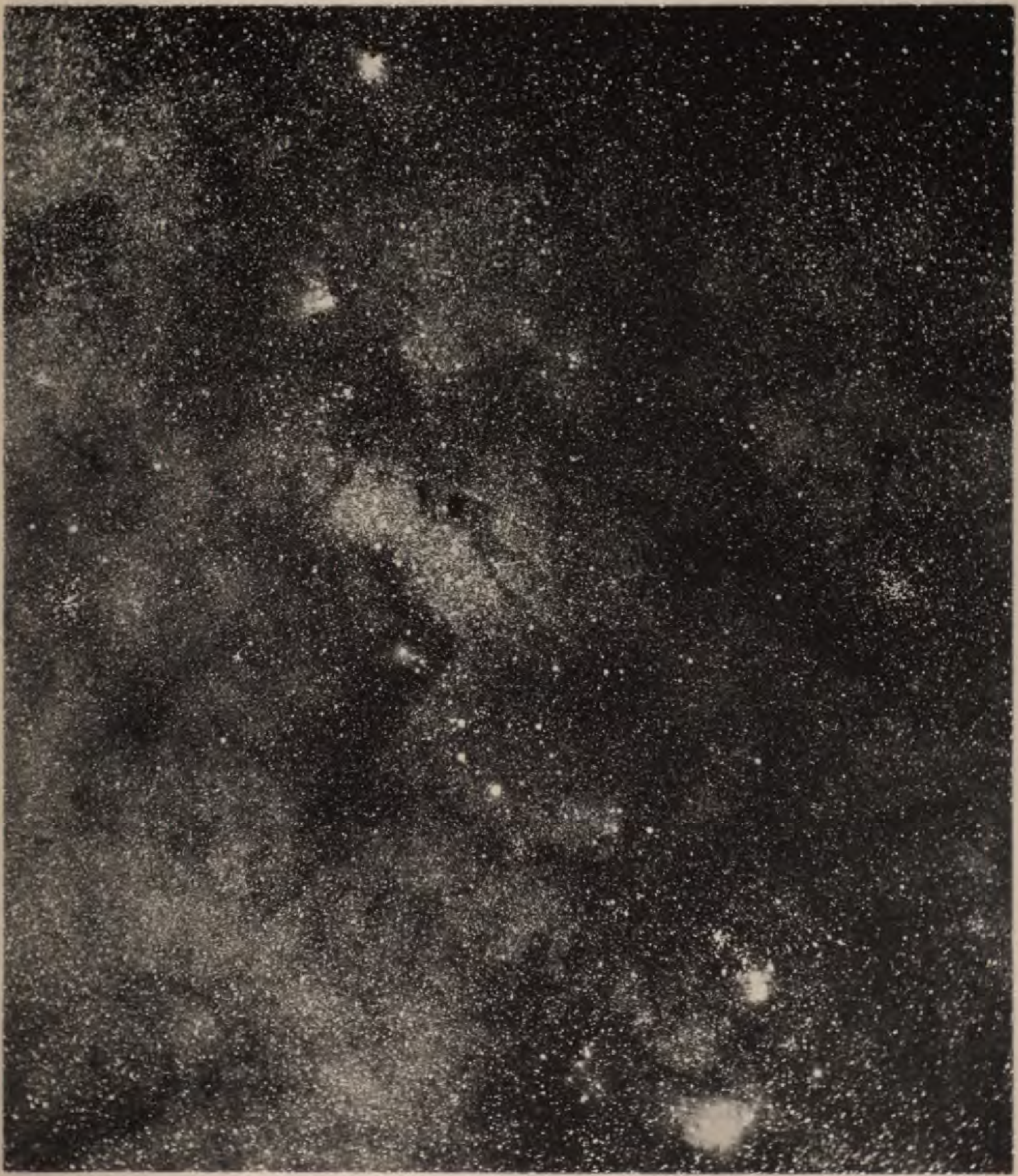

PLATE 55

SMALL STAR CLOUD AND HOLES IN SAGITTARIUS (ENLARGED)

(Top is north) (Scale: 1 cm. = 24'.1)
1855.0 α 18^h 7^m δ $-18^\circ.3$
1892 June 20 Exposure 4^h 30^m

This enlargement of the region of Plate 54 is intended to show the structure of the star cloud more clearly.

In the upper left quadrant the nebula M 17, popularly known as the **Swan** or **Omega** Nebula, is seen to occupy, with its fainter extensions, an area nearly one degree in diameter. The companion to the small star in the small black hole in the star cloud is easily visible close to the right of it. The position of the black hole is

1855.0 18^h 7^m -18° $15'$

The nebulous star BD — 19° 4953 is really the principal one of a group of nebulous stars which consists of the following:

BD - 19° 4953	Involved in dense nebulosity
- 18° 4954	
- 18° 4943	
- 18° 4940	Small, dense nebulosity
- 18° 4948	Small, dense nebulosity

IDENTIFICATION OF STARS, ETC.

Object	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	'		In.	mm.		In.	mm.
BD - 18° 4845 . . .	8 2	1855 0	18	5	23.0	- 18	47.8	B	3.7 =	94	R	2.7 =	69
BD - 18° 4853 . . .	9 2	1855.0	18	5	59.1	- 18	18.5	B	4.3	109	R	2.8	71
BD - 18° 4863[1] . . .	9.0	1855.0	18	6	58.0	- 18	24.2	B	4.1	104	R	3.0	76
BD - 18° 4871[2] . . .	8.4	1855.0	18	7	25.9	- 18	17.1	T	4.0	102	R	3.2	81
BD - 19° 4953 . . .	7.6	1855.0	18	9	5.6	- 19	42.8	B	2.8	71	L	2.7	69
BD - 17° 5203 . . .	6.7	1855.0	18	19	28.1	- 17	52.9	T	3.6	91	L	0.3	8
Dreyer 6618 = M 17	. . .	1860.0	18	12	42	- 16	13.9	T	2.0	51	L	1.9	48

[1] On lower edge of hole.
[2] On left edge of hole.

ADDITIONAL NOTE ON THE BLACK "HOLE"

The small star, near the middle of the small black "hole," was observed with the micrometer of the 40-inch telescope of the Yerkes Observatory, on July 6, 1913. The resulting position is: 1913.0 $\alpha = 18^h\ 10^m\ 28^s.82$, $\delta = -18^\circ\ 15'\ 27''.3$. Several smaller stars near it were also measured with respect to this star, which we will call ***a***, in the summers of 1911–13. The small star close preceding *a* (which is readily seen on the plate with slight magnification) we will call *b*.

		Pos. Ang.	Dist.	Mags.		No. of Obs.
ab	1911.842	282° 88	80".46	11.9	13.6	5n
bc	1911.426	4 .30	25 .38	. . .	15.5	3n
ad	1913.573	175 .98	42 .28	. . .	16	2n

See *Ap. J.* 38, 496–501, 1913

For observations of this remarkable black spot itself with the 40-inch telescope, see a quotation on **page 21** of the present volume.

PLATE 56

IN SAGITTARIUS—NEAR M 22

(Top is north) (Scale: 1 cm. = 44′.4)

1855.0 α 18^h 16^m δ $-25°.0$

1895 June 28 Exposure 3^h 0^m

This plate shows the eastern edge of the great star clouds of Plates 49 and 50, etc. It will be seen that these clouds fade off gradually into the ordinary sky to the east, in strong contrast to the abrupt termination of their western sides. The stars become, apparently, very small; whether due to this part of the Milky Way receding into distant space at this point or to an actual smallness of the stars would be difficult to tell.

Much structure of a dark nature exists in the bright region, especially below M 22. This cluster is a splendid object. It covers at least 25 minutes and is somewhat elongated north and south. Its outlines seem to have a greater extent on its west side. In about the position (1855.0) α 18^h 25^m 40^s, δ $-21°$ $30'$ is a singularly small and sharply defined black spot, elongated east and west, with a small star in its east end.

With the exception of a strong halation about φ **Sagittarii** the plate seems to be free of defects.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.			Distance from Edge of Plate.			
			h m s	° ′		In. mm.		In. mm.
Small, black spot	. . .	1855.0	18 25 40	−21 30	T	1.2=30	L	2.3=58
Group of nebulous stars. (See Plate 52)	. . .		. . . . . .	. . .	T	2.5 64	R	1.0 25
δ **Sagittarii**	2.8	1875.0	18 13 0.8	−29 52.7	B	0.6 15	R	2.4 61
φ **Sagittarii**	3.7	1875.0	18 37 51.1	−27 7.3	B	2.2 56	L	0.7 18
Dreyer 6523 = M 8	. . .	1860.0	17 55 6	−24 22.8	T	2.8 71	R	0.2 51
Dreyer 6626 = M 28	. . .	1860.0	18 15 56	−24 56.1	T	3.2 81	R	3.0 76
Dreyer 6656 = M 22	. . .	1860.0	18 27 51	−24 1.0	T	2.7 69	L	1.9 48

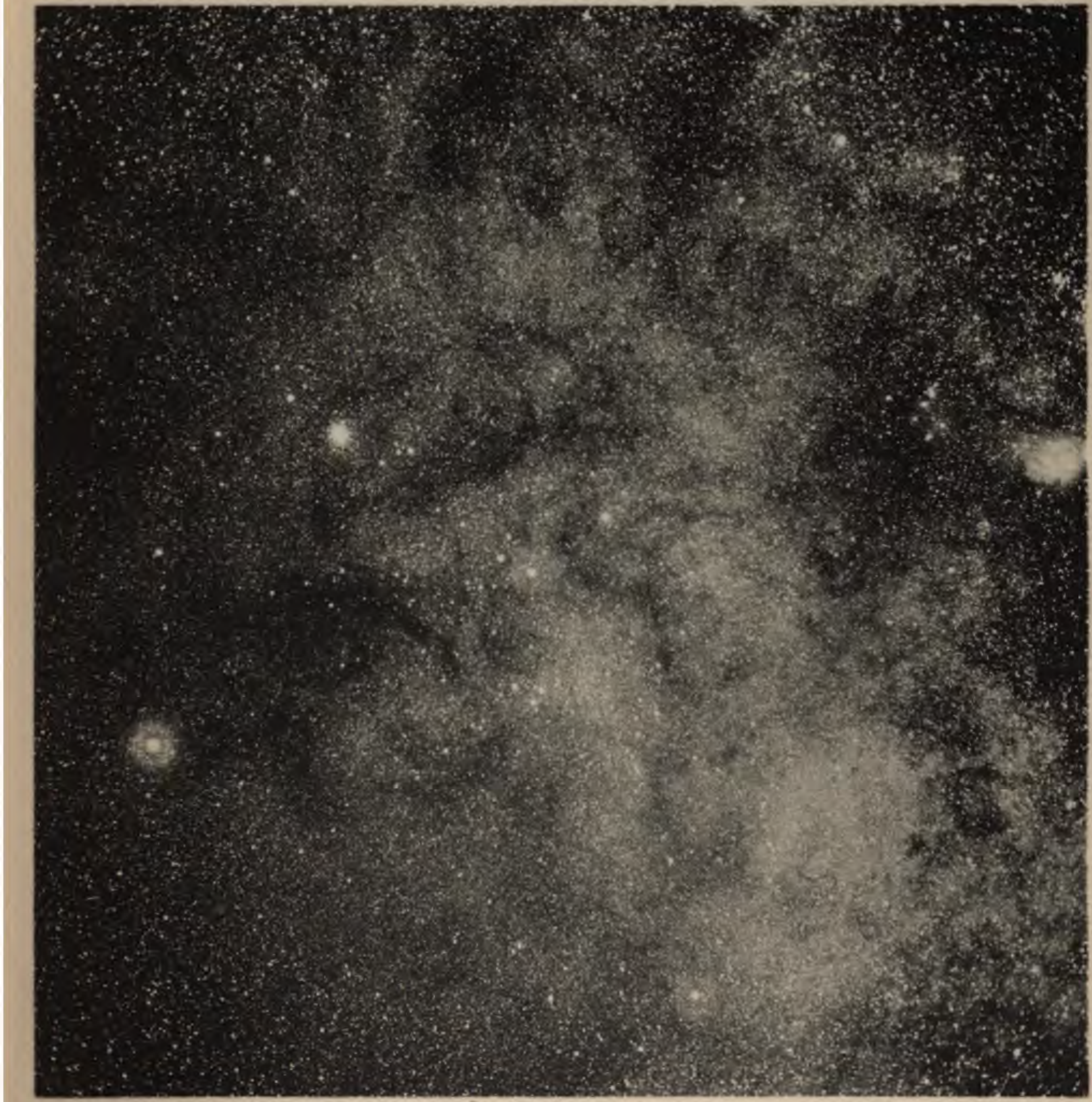

PLATE 57

IN SAGITTARIUS

(Top is north) (Scale: 1 cm. = 39′.4)
1855.0 α 18^h 23^m δ − 14°.5
1895 July 25 Exposure 4^h 25^m

This is a very interesting region. Messier 16, the upper of the two nebulæ to the right of the middle, is a remarkable object much resembling the great nebula of **Orion** as photographed with a small telescope. Dreyer gives M 16 simply as a cluster and does not mention any nebulosity. Its nebulous condition was shown in my earliest photographs, and the discovery of the nebulosity, therefore, is due to photography. I have given a description of its appearance in *A. N.* **177**, 231, 1908. Dr. Roberts gives a photograph of this object in Volume II (Plate 151) of his Celestial Photographs.

For a photographic description of M 17 (the lower of the two nebulæ), see *A. N.* **177**, 231, 1908.

In the upper part of the plate is the star BD — 10° 4713 of the 5.5 magnitude (Dreyer *Index Catalog* 1287) which is densely nebulous (*A. N.* **130**, 233, 1892). With the 10-inch Bruce telescope it is a remarkable object. The nebula does not seem to condense strongly at the star, but a stronger, roundish patch of it, one or two minutes in diameter, lies close south preceding the star. There is a tendency to wispiness in the nebula, resembling in this respect some of the nebulosities of the **Pleiades**. A long curved nebulous strip northwest of the star is concave toward it and reaches westward to a smaller star. This nebulosity looks as if it would well repay investigation with some of the large reflectors. This object (BD — 10° 4713), is in a larger, partly vacant, region some 3° — 4° in width. The arrangement of the star masses surrounding this vacancy seems to suggest the idea that some force radiating from this point may have affected the distribution of the stars about it in all directions.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.			Distance from Edge of Plate.					
			h m s	° ′		In.	mm.		In	mm
BD − 10° 4713	5.5	1855.0	18 23 23.9	− 10 53.4	T	1.3 =	33	R	3.0 =	76
Dreyer 6611 = M 16	. . .	1860.0	18 10 57	− 13 50.0	B	4.2	107	R	1.2	30
Dreyer 6618 = M 17	. . .	1860.0	18 12 42	− 16 13.9	B	2.8	71	R	1.5	38
Dreyer *2d Index Catalog* 4745	. . .	1860.0	18 23 26	− 19 20	B	1.0	25	R	3 0	76
Dreyer 6445	. . .	1860.0	18 24 32	− 16 59.1	B	2.4	61	R	3.1	79

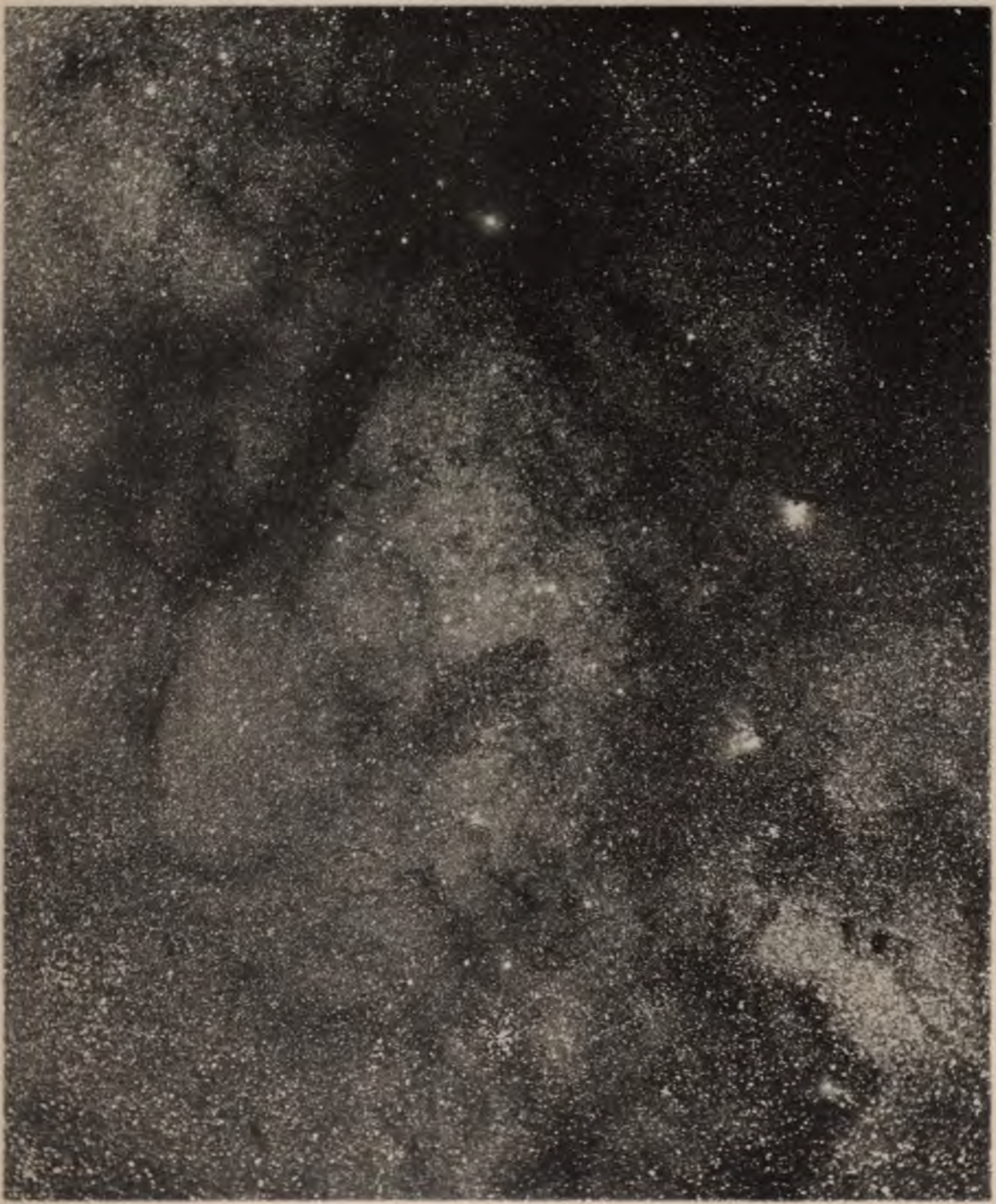

PLATE 58

IN SAGITTARIUS (ENLARGED)

(Top is north) (Scale: 1 cm. = 24′.4)
1855.0 α $18^h\ 22^m$ δ $-13^\circ.5$
1895 July 25 Exposure $4^h\ 25^m$

This enlargement brings out the individual stars to some advantage, but it loses somewhat the general characteristics of Plate 57. The nebulous star is well shown, as are also some of the dark spots, especially the one 1.7 inches to the southwest of the nebulous star.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.			Distance from Edge of Plate.					
			h m s	° ′		In.	mm.		In.	mm.
BD – 10° 4713 . . .	5.5	1855.0	18 23 23.9	– 10 53.4	T	1.5 =	38	L	2.9 =	74
Dreyer 6611 = M 16	. . .	1860.0	18 10 57	– 13 50.0	B	4.3	109	R	0.8	20
Dreyer 6618 = M 17	. . .	1860.0	18 12 42	– 16 13.9	B	2.0	51	R	1.3	33
Dreyer 6645	. . .	1860.0	18 24 32	– 16 59.1	B	1.2	30	L	2.7	69

PLATE 59

IN SERPENS

(Top is north) (Scale: 1 cm. = 36′.8)
1855.0 α $18^h 25^m$ δ +7°.0
1894 September 21 Exposure $3^h 5^m$

This region of the sky is apparently made up of relatively very small stars with a few brighter ones in two scattering clusters. In the lower part of the picture the southern edge of this rich region of small stars assumes a cloud form effect where it borders on the poor region below. There is no nebulosity on the plate, and the slight increase of brightness along the right edge is unreal.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.			Distance from Edge of Plate.					
			h m s	° ′		In.	mm.		In.	mm.
BD + 6° 3855	5.8	1855.0	18 29 36.8	+ 6 33.4	T	3.9=	99	L	2.7=	69
BD + 1° 3766	5.0	1855.0	18 37 31.2	+ 1 55.1	B	1.2	30	L	1.4	36
BD + 5° 3941	6.3	1855.0	18 38 20.7	+ 5 21.3	B	3.4	86	L	1.3	33
Dreyer 6633	. . .	1860.0	18 20 43	+ 6 28.7	T	4.0	102	R	3.1	79
Dreyer 6907	. . .	1860.0	18 44 53	+10 11.0	T	1.6	41	L	0.3	8

DEFECTS

Description.	Distance from Edge of Plate.					
		In.	mm		In.	mm.
Slightly luminous, like a patch of faint stars	T	2.0=	51	L	3.6=	91
Slightly luminous, like a patch of faint stars	T	3.0	76	L	3.7	94

Compare with Plate 60.

PLATE 60

IN OPHIUCHUS

(Top is north) (Scale: 1 cm. = 37′.7)

1855.0 α 18^{h} 30^{m} δ +9°.5

1895 August 15 Exposure 4^{h} 30^{m}

This region joins that of Plate 59. The reproduction has given coarser star images, but it is otherwise fair. The luminosity at the lower right corner is unreal.

In the upper part of the plate is a nearly vacant region, and the upper part of the rich star mass joining it is quite definite and shows some structure.

IDENTIFICATION OF STARS, ETC.

Object.	Mag	Place.			Distance from Edge of Plate.			
			h m s	° ′		In. mm.		In. mm.
BD + 6° 3855	5.0	1855.0	18 29 36.8	+ 6 33.4	B	2.8 = 71	R	3.2 = 81
BD + 5° 3941	6.3	1855.0	18 38 20.7	+ 5 21.3	B	2.0 51	L	2.5 64
BD + 4° 3916	4.0	1855.0	18 49 0.8	+ 4 0.8	B	1.2 30	L	0.9 23
Dreyer 6633	. . .	1860.0	18 20 43	+ 6 28.7	B	2.7 69	R	1.7 43
Dreyer 6907	. . .	1860.0	18 44 53	+ 10 11.0	T	3.2 81	L	1.6 41

PLATE 61

IN LYRA—NEAR VEGA

(Top is north) (Scale: 1 cm. = 36′.5)
1855.0 α $18^h 33^m$ δ $+39^\circ.5$
1894 August 11 Exposure $2^h 21^m$

The entire background, which is a little luminous near the right side of the plate, should be uniformly dark, as there are no nebulosities.

The stars are fairly uniformly scattered over the sky here, but there almost appears to be an increase of them in the immediate region of Vega.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.			Distance from Edge of Plate.	
			h m s	° ′	In. mm.	In. mm.
BD + 42° 3035 . . .	5.5	1855.0	18 11 8.3	+42 7.8	T 1.6 = 41	R 0.9 = 23
Vega	1.0	1855.0	18 32 1.9	+38 39.1	B 3.9 99	R 3.4 86
ε Lyræ	4.3	1555.0	18 39 31.9	+39 31.3	T 3.5 89	L 2.4 61
ζ Lyræ	4.5	1855.0	18 39 46.7	+37 27.7	B 3.1 79	L 2.4 61
BD + 33° 3223 . . .	Var.	1855.0	18 44 44.4	+33 12.2	B 0.3 8	L 1.8 46

PLATE 62

GREAT STAR CLOUD IN AQUILA—WEST OF M 11

(Top is north)   (Scale: 1 cm. = 35′.0)
1855.0 α $18^h 33^m$ δ −6°.9
1895 July 26   Exposure $4^h 30^m$

This splendid star cloud is one of the finest in the Milky Way. It is a striking object to the unaided eye, and even the casual observer of the sky must be attracted by its definite form. The photograph readily reveals its stellar structure. It might be described as a great mass of stars widely extending to the east with a rather narrow "neck" from which the great definite mass of stars, or "head," piles up near the middle of the plate. This "head" is sharply indented on the west by several "saw-tooth" projections. From the 4½ magnitude star (—4° 4582) in the upper part, rise two curved sprays of stars, curiously like the horns of a ram, while to the west and north are several detached masses of stars. Many small black spots—some very small and black—appear in the main body of the cloud itself. These last are very striking objects on photographs made with the 10-inch Bruce telescope of the Yerkes Observatory.

On the upper part of the "neck" of the cloud is the small bright cluster M 11, which is shown as an irregular white spot. Its apparent connection with the great star cloud is probably a real one and not a matter of projection.

About one half a degree above the nebulous star in the lower right quadrant is a curious elliptical dark spot, with a patch of stars in it.

Unfortunately, this reproduction is not perfect. The region immediately to the west and north of the great cloud has not been printed dark enough. This fault somewhat accentuates the blackness of the sky close to the edge of the great mass. By comparison with Plates 64 and 65, however, the true relation of light and shade will be recognized.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.			Distance from Edge of Plate.					
			h m s	° ′		In	mm.		In.	mm.
BD − 2° 4599 . . .	3	1855.0	18 13 47.9	− 2 56.1	T	1 5 =	38	R	0.5 =	13
BD − 10° 4713 . . .	5.5	1855.0	18 23 23.9	− 10 53.4	B	2.4	61	R	2.3	58
BD − 9° 4796 . . .	5.0	1855.0	18 34 20.1	− 9 11.2	B	3.6	91	L	3.5	89
BD − 8° 4686 . . .	5.5	1855.0	18 35 37.2	− 8 25.1	B	4.2	107	L	3.3	84
BD − 4° 4582 . . .	4.5	1855.0	18 39 29.8	− 4 53.8	T	2.8	71	L	2.8	71
BD − 13° 5172 . . .	5 5	1855.0	18 51 15.1	− 13 1.7	B	1.1	28	L	0.7	18
BD − 3° 4460 . . .	5.7	1855.0	18 55 16.1	− 3 54.5	T	2.0	51	L	0.1	3
Dreyer 6611 = M 16	. . .	1860.0	18 10 57	− 13 50.0	B	0.3	8	R	0.3	8
Dreyer 6494 = M 26	. . .	1860.0	18 37 33	− 9 32.0	B	3.4	86	L	3.0	76
Dreyer 6705 = M 11	. . .	1860.0	18 43 33	− 6 25.9	T	3.8	97	L	2.1	53

PLATE 63

GREAT STAR CLOUD IN AQUILA—NEAR M 11 (ENLARGED)

(Top is north) (Scale: 1 cm. = 25′.2)
1855.0 α 18^h 41^m δ −7°.0
1895 July 26 Exposure 4^h 30^m

This enlargement shows some of the features of the great star cloud much better. It is quite free from defects. The "saw-tooth" projections on the west side are fairly well shown, and still west of these is a thin sprinkling of small stars. A few of the dark markings of the main body are also shown. Immediately above M 11 are a number of very singular dark markings that are not so well reproduced. From the photograph, it is evident that the outlying stars of M 11 cover a much greater extent of the sky than a telescopic view of the cluster would indicate. Apparently, it extends into a larger mass of stars nearly one half a degree to the west.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.			Distance from Edge of Plate.					
			h m s	° ′		In.	mm.		In.	mm.
BD 9° 4796	5.0	1855.0	18 34 20.1	−9 11.2	B	2.3	= 58	R	2.0	= 51
BD 8° 4686	5.5	1855.0	18 35 37.2	−8 25.1	B	3.1	79	R	2.3	58
BD −4° 4582	4.5	1855.0	18 39 28.9	−4 53.8	T	2.2	56	R	3.1	79
Dreyer 6694 M 26	. . .	1860.0	18 37 33	−9 32.0	B	2.0	51	R	2.7	69
Dreyer 6705 M 11	. . .	1860.0	18 43 33	−6 25.9	T	3.6	91	L	2.7	69

DEFECTS

Description	Distance from Edge of Plate.					
		In.	mm.		In.	mm.
Small, white, irregular	B	2.6	= 66	R	1.1	= 28

PLATE 64

GREAT STAR CLOUD IN AQUILA—SOUTH OF M 11

(Top is north) (Scale: 1 cm. = 38′.7)
1855.0 α 18^{h} 41^{m} δ $-8^{\circ}.0$
1895 August 16 Exposure 5^{h} 10^{m}

The present picture shows the eastern part of the great cloud very satisfactorily. The semi-vacant lanes and the dark spots are fairly well shown, especially in the lower half of the plate. Other photographs show that this remarkable cloud of stars diffuses imperceptibly into the regular sky towards the east.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.			Distance from Edge of Plate.					
			h m s	° ′		In.	mm.		In.	mm.
BD − 10° 4713 . . .	5.5	1855.0	18 23 23.9	− 10 53.4	B	2.6 =	66	R	0.4 =	10
BD − 9° 4796 . . .	5.0	1855.0	18 34 20.1	− 9 11.2	B	3.6	91	R	2.0	51
BD − 8° 4686 . . .	5.5	1855.0	18 35 37.2	− 8 25.1	B	4.1	104	R	2.2	56
BD − 4° 4582 . . .	4.5	1855.0	18 39 29.8	− 4 53.8	T	1.7	43	R	2.8	71
BD − 13° 5172 . . .	5.5	1855.0	18 51 15.1	− 13 1.7	B	1.3	33	L	2.3	58
BD − 3° 4460 . . .	5.7	1855.0	18 55 16.1	− 3 54.5	T	1.1	28	L	1.7	43
BD − 5° 4876 . . .	3	1855.0	18 58 34.3	− 5 5.5	T	1.8	46	L	1.2	30
Dreyer 6694 = M 26	. . .	1860.0	18 37 33	− 9 32.0	B	3.4	86	R	2.5	64
Dreyer 6705 = M 11	. . .	1860.0	18 43 33	− 6 25.9	T	2.7	69	R	3.4	86

PLATE 65

GREAT STAR CLOUD IN AQUILA—NEAR M 11

(Top is north) (Scale: 1 cm. = 43′.3)

1855.0 α $18^h 42^m$ δ −5°.9

1892 June 29 Exposure $3^h 20^m$

This early photograph, with an insufficient exposure, or from the use of a less sensitive plate, gives the cloud a more isolated appearance than the other plates, in which the rich region of small stars in the southeastern part is brought out more strongly. The brighter parts of the cloud are, perhaps, better shown here near the middle of the plate. It must be studied, however, in conjunction with Plates 62, 63 and 64 which it supplements.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.			Distance from Edge of Plate.					
			h m s	° ′		In.	mm.		In.	mm.
BD 10° 4713 . . .	5.5	1855.0	18 23 23.9	−10 53.4	B	1.3 =	33	R	0.7 =	18
BD 9° 4796 . . .	5.0	1855.0	18 34 20.1	− 9 11.2	B	2.2	56	R	2.2	56
BD - 8° 4686 . . .	5.5	1855.0	18 35 37.2	− 8 25.1	B	2.7	69	R	2.4	61
BD - 4° 4582 . . .	4.5	1855.0	18 39 28.9	− 5 53.8	T	2.7	69	R	2.9	74
BD 5° 4876 . . .	3.0	1855.0	18 58 34.3	− 5 5 5	T	2.8	71	L	0.7	18
Dreyer 6694 M 26	. . .	1860.0	18 37 33	− 9 32.0	B	2.0	51	R	2.6	66
Dreyer 6705 M 11	. . .	1860.0	18 43 33	− 6 25.9	B	3.7	94	L	2.8	71

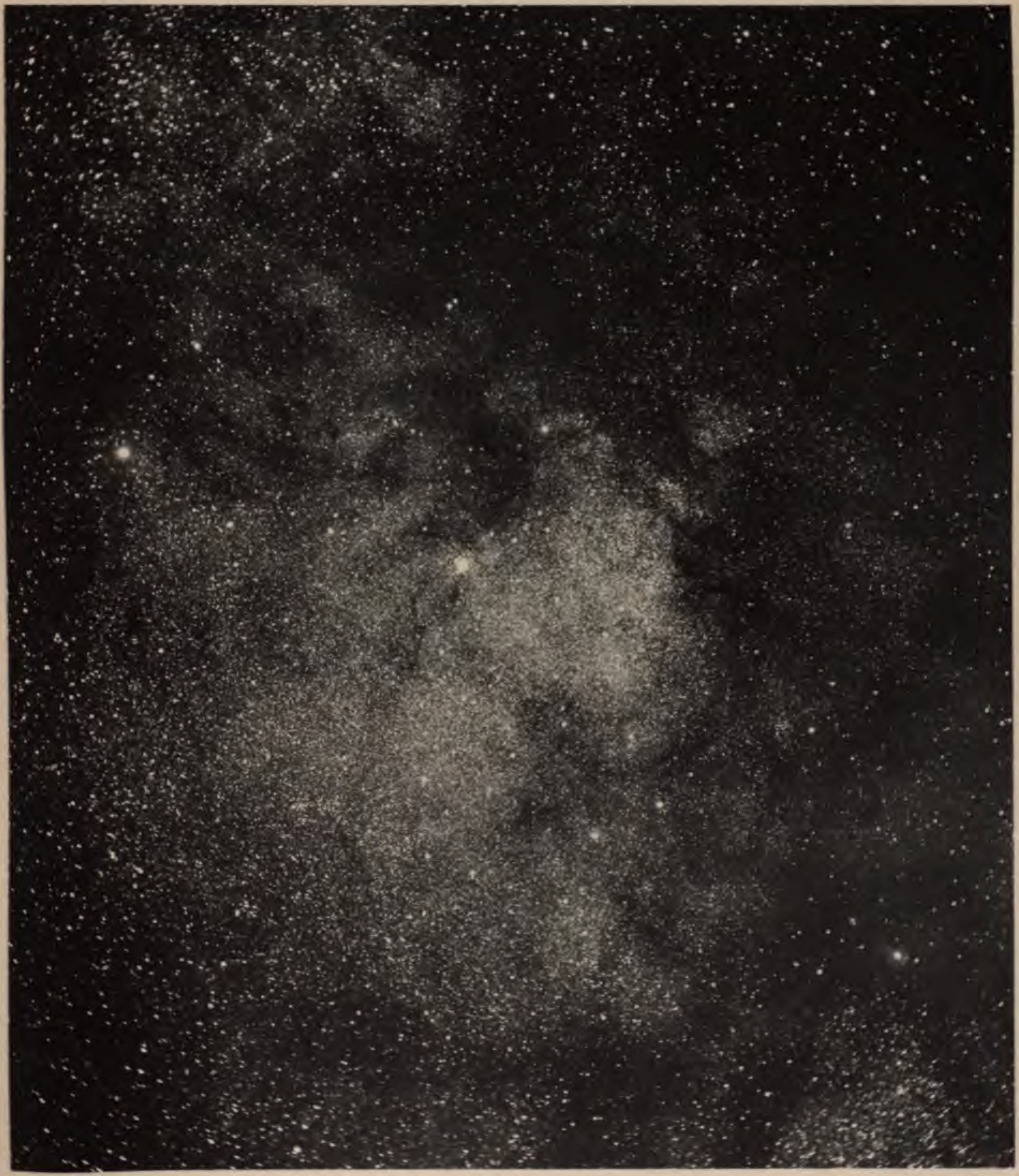

PLATE 66

IN AQUILA—NEAR ζ AQUILÆ

(Top is north) (Scale: 1 cm. = 37′.1))
1855.0 α 18h 54m δ + 14°.3
1895 August 20 Exposure 5h 30m

The structure of the Milky Way in this region is fairly well brought out, especially the cloud forms near ζ **Aquilæ**.

The plate is quite free from defects, except in the lower right corner, where the sky is a little too light.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.			Distance from Edge of Plate.					
			h m s	° ′		In.	mm.		In	mm.
BD + 18° 3823	4.1	1855.0	18 40 37.3	+ 18 1.6	T	1.0	= 25	R	1.0	= 25
ε **Aquilæ**	3.9	1855.0	18 53 3.3	+ 14 52.7	T	3.0	76	R	2.9	74
ζ **Aquilæ**	3.0	1855.0	18 58 44.8	+ 13 39.0	B	3 5	89	L	2.7	69
BD + 10° 3787	Var.	1855.0	19 0 9.3	+ 10 51.2	B	1.7	43	L	2.5	64
BD + 16° 3752	5.5	1855.0	19 1 27.3	+ 16 38.6	T	1.9	48	L	2.3	58
BD + 14° 3852	5.9	1855.0	19 9 48.7	+ 14 17.2	B	3.9	99	L	1.0	25
BD + 12° 3879	5.5	1855.0	19 12 52.7	+ 12 6.6	B	2.5	64	L	0.5	13

PLATE 67

IN AQUILA—NEAR δ AQUILÆ

(Top is north) (Scale: 1 cm. = 46′.5)
1855.0 α $19^h\ 12^m$ δ +2°.5
1895 June 21 Exposure $4^h\ 5^m$

At the upper edge, near the left corner, the plate is printed too light, otherwise the reproduction is a fair one.

The most remarkable object is the long, curved dark rift running from the middle of the plate, southwards, and convex to the west. It is sharply defined on its eastern side where it abruptly breaks the continuity of the bed of stars, while the western edge is less marked. If the stars west of this rift did not exist, or were fainter, it would leave a cloud-like form closely resembling that near M 11 (Plate 65). Just below its lower part there is a peculiar radiating structure of short lines of stars which are rather brighter than those of the immediate background. Beyond this are some irregular dark crevices. In a plate with the 10-inch Bruce telescope of the Yerkes Observatory this object is very remarkable. It seems to start from a small very black spot in its south end and to run in a curved line northwards and end in dark, branching structures. The southwest quadrant of the plate shows the star clouds north of the region of M 11.

There are two palpable defects; a thin light streak in the lower left corner, and a short thin light line one half inch to the right of BD — 1° 3732.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In.	mm.
θ Serpentis . . .	4.0	1855.0	18	49	0.8	+4	0.8	T	2.4 =	61	R	0.1 =	3
λ Aquilæ	3	1855.0	18	58	34.3	−5	5.5	B	0.2	5	R	1.4	36
δ Aquilæ	3.2	1855.0	19	18	11.4	+2	50.0	T	3.0	76	L	2.3	58
BD − 1° 3782	4.2	1855.0	19	29	14.3	−1	35.7	B	2.1	53	L	0.8	20

PLATE 68

IN AQUILA—EAST OF ζ AQUILÆ

(Top is north) (Scale: 1 cm.=36′.5)
1855.0 α $19^h\ 14^m$ δ +14°.8
1894 September 6 Exposure $2^h\ 13^m$

This shows the region between ζ **Aquilæ** and **Altair**. The star clouds to the lower left side of the plate are a part of those in which **Altair** is placed. The dark holes near the lower left corner are fairly well shown. The western edge of this cloud region opens on to a very thin space, which covers irregularly a large part of the middle of the plate, a smaller cloud being conspicuous close west of the middle. From this on, to the west, a brighter region is entered, about and above ζ **Aquilæ**. The upper right quadrant is more or less irregular, with partial vacancies. The luminous portion two inches from the bottom near the right side is partly unreal.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.			Distance from Edge of Plate.					
			h m s	° ′		In.	mm.		In.	mm.
ζ **Aquilæ**	3.0	1855.0	18 58 44.8	+13 39.0	B	3.4=	86	R	1.1=	28
BD+10° 3787 . . .	Var.	1855.0	19 0 9.3	+10 51.2	B	1.6	41	R	1.2	30
BD+16° 3752 . . .	5.5	1855.0	19 1 27.3	+16 38.6	T	2 5	64	R	1.5	38
BD+14° 3852 . . .	5.9	1855.0	19 9 48.7	+14 17.2	B	3.8	97	R	2.8	71
BD+12° 3879 . . .	5.5	1855.0	19 12 52.7	+12 6.6	B	2.4	61	R	3.3	84
BD+11° 3833 . . .	5.5	1855.0	19 18 3.4	+11 38.7	B	2.1	53	L	2.6	66
BD+19° 4063 . . .	5.8	1855.0	19 28 13.3	+19 27.6	T	0.7	18	L	1.1	28

DEFECTS

Description.	Distance from Edge of Plate.					
		In.	mm.		In.	mm.
Small, light, irregular	B	3.2=	81	R	3.2=	81

PLATE 69

IN AQUILA—WEST OF α AQUILÆ

(Top is north.) (Scale: 1 cm = 46′.5)
1855.0 α 19^h 26^m δ +8°.4
1895 August 17 Exposure 5^h 10^m

The plate is quite free from defects except an unfortunate one that has occurred in the printing. This is on the southeast edge of the upper dark marking some 3½ degrees northwest of Altair. This defect resembles a small cluster of stars and is found 2.4 inches from the top and 2.2 inches from the left side of the plate.

This is a very rich region and the western edge of the star clouds is quite definitely marked. The small star cloud to the right of the middle strongly resembles the greater one near M 11 (Plate 65). A black spot near its southwest edge, about 40 minutes in diameter, is very noticeable. On the upper edge of this hole is the $7^m.8$ star +7° 4028.

The singular dark markings northeast of **Altair** are striking features and are shown in my earliest photographs.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.			Distance from Edge of Plate.					
			h m s	° ′		In.	mm.		In.	mm.
BD + 2° 3824 . . .	5.6	1855.0	19 6 24.0	+ 2 2.9	B	1.0	=25	R	0.6	=15
BD + 12° 3879 . . .	5.5	1855.0	19 12 52.7	+12 6.6	T	1.6	41	R	1.5	38
BD + 11° 3833 . . .	5.5	1855.0	19 18 3.4	+11 38.7	T	1.8	46	R	2.2	56
δ **Aquilæ**	3.2	1855.0	19 18 11.4	+ 2 50.0	B	1.4	36	R	2.2	56
γ **Aquilæ**	3.0	1855.0	19 39 22.0	+10 15.9	T	2.5	64	L	1.5	38
Altair	1.2	1855.0	19 43 43.2	+ 8 29.3	T	3.5	89	L	0.8	20
η **Aquilæ**	Var.	1855.0	19 45 5.2	+ 0 38.2	B	0.2	5	L	0.6	15
β **Aquilæ**	4.0	1855.0	19 48 11.6	+ 6 3.0	B	3.2	81	L	0.3	8

DEFECTS

Description.	Distance from Edge of Plate.					
		In.	mm.		In.	mm.
Small, light, granular	T	2.5	=64	L	2.2	=56

21—L

PLATE 70

IN CYGNUS—REGION OF β CYGNI

(Top is north) (Scale: 1 cm. = 44′.1)
1855.0 α 19^h 30^m δ +29°.0
1893 October 12 Exposure 4^h 43^m

This very rich region is much broken in the southeastern half of the plate. One remarkable feature is the coarseness of the stars in the northeast quadrant compared to those to the south and west of β **Cygni**, which are very minute, and which have the appearance of forming a more or less distant part of the Milky Way. This difference may be somewhat accentuated in the reproduction.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.			Distance from Edge of Plate.					
			h m s	° ′		In.	mm.		In.	mm.
BD+21° 3713	4.7	1855.0	19 9 59.8	+21 8.2	B	0.9=	23	R	0.6=	15
BD+25° 3811	5.5	1855.0	19 16 54.7	+25 59.4	B	3.5	89	R	1.5	38
BD+29° 3584	5.2	1855.0	19 18 24.5	+29 20.2	T	3.5	89	R	1.7	43
β Cygni	3.0	1855.0	19 24 53.1	+27 39.3	B	4.4	112	R	2.5	64
BD+34° 3590	4.6	1855.0	19 26 23.1	+34 8.7	T	0.9	23	R	2.7	69
BD+23° 3820	4.6	1855.0	19 47 18.1	+23 42.0	B	2.3	58	L	1.2	30
BD+31° 3925	6.0	1855.0	19 58 55.2	+31 48.8	T	2 0	51	L	0.1	3
Dreyer 6853 = M 27 = **Dumbbell Nebula** . . .	. . .	1860.0	19 53 33	+22 20.4	B	1.6	41	L	0.4	10

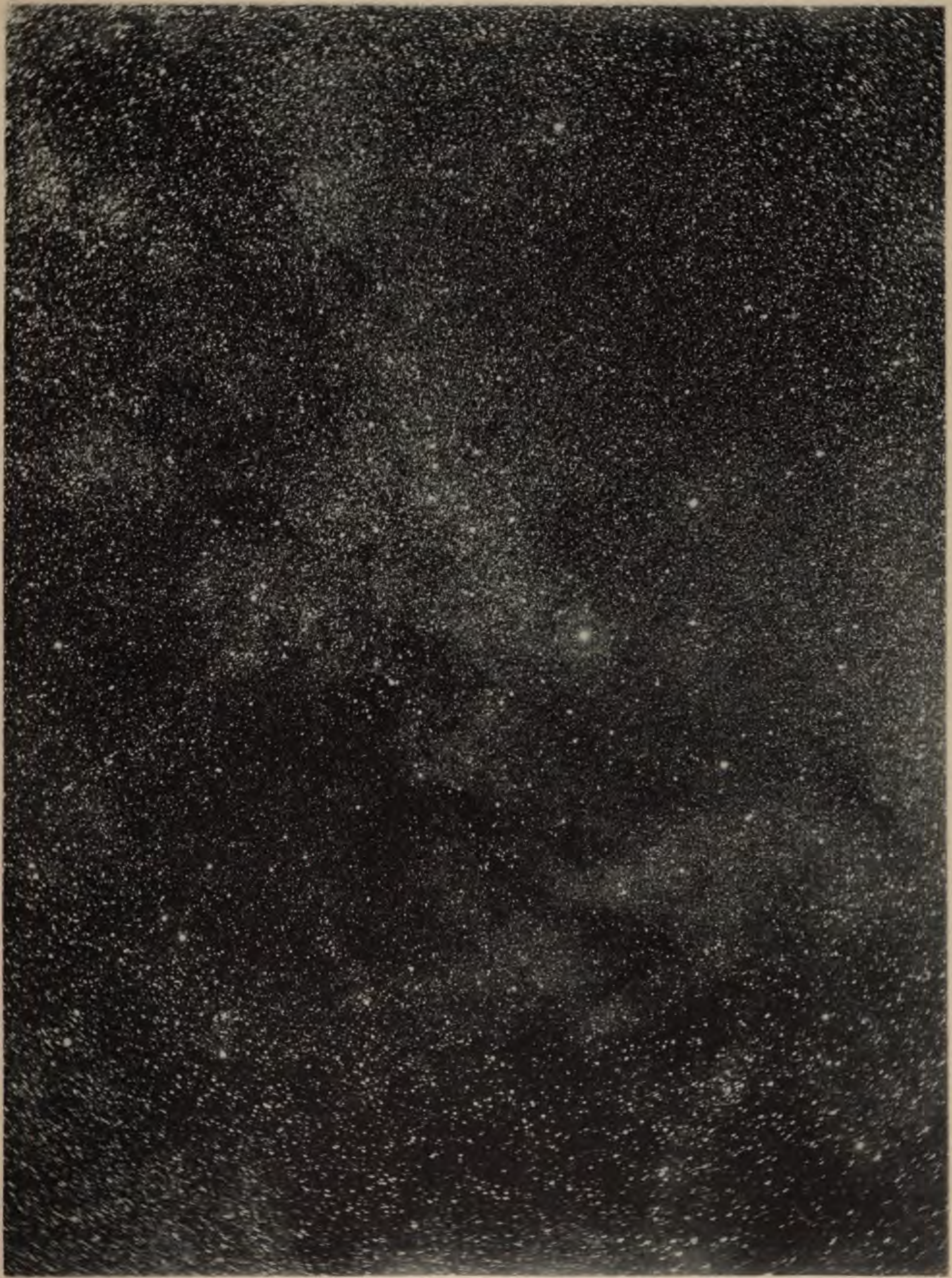

PLATE 71

IN AQUILA—NORTHWEST OF α AQUILÆ

Discovery of Comet 1892 V (1855.0 α $19^h\ 30^m.0$ ± δ +12° 45′ ±)

(Top is north) (Scale: 1 cm. = 46′.5)
1855.0 α $19^h\ 37^m$ δ +12°.0
1892 October 12 Exposure $4^h\ 20^m$

This plate, unfortunately, is printed a little too dark and some of the features shown so well in Plate 69 are nearly lost through an excess of ink. It shows the dark spots northwest of **Altair** fairly well, but not so well as Plate 69 or even Plate 68.

This photograph contains the discovery of Comet V 1892. The trail of the comet will be found 2.5 inches from the right side and 3.3 inches from the top of the plate. A lens of small magnifying power will show it well. (See also Plate 101, where an enlargement is given.)

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.			Distance from Edge of Plate.					
			h m s	° ′		In	mm.		In.	mm.
BD + 12° 3879 . . .	5.5	1855.0	19 12 52.7	+12 6.6	T	3.6=	91	R	0.2=	5
BD + 11° 3833 . . .	5 5	1855.0	19 18 3.4	+11 38.7	T	3.9	99	R	0.9	23
BD + 13° 4020 . . .	6.0	1855.0	19 20 53.9	+13 59.4	T	2.6	66	R	1.3	33
Comet V 1892 . . .	. . .	1855.0	19 30.0 ±	+12 45 ±	T	3.3	84	R	2.5	64
BD + 17° 4042 . . .	4 3	1855.0	19 33 37.2	+17 41.6	T	0.6	15	R	3.0	76
γ **Aquilæ**	3.0	1855.0	19 39 22.0	+10 15.9	B	3.3	84	L	2.7	69
BD + 18° 4240 . . .	4.0	1855.0	19 40 55.2	+18 10.5	T	0.4	10	L	2.5	64
Altair	1.2	1855.0	19 43 43.2	+ 8 29.3	B	2.4	61	L	2.2	56
β **Aquilæ**	4.0	1855.0	19 48 11.6	+ 6 3.0	B	1.0	25	L	1.6	41
BD + 16° 4067 . . .	Var.	1855.0	19 49 25.3	+16 15.4	T	1.4	36	L	1.4	36
Dreyer 6838 = M 71	. . .	1860.0	19 47 30	+18 24.9	T	0.3	8	L	1.7	43

PLATE 72

IN SAGITTARIUS

(Top is north) (Scale: 1 cm. = 36′.2)
1855.0 α $19^h\ 55^m$ δ − 13°.5
1894 October 2 Exposure $2^h\ 35^m$

The short trails to the brighter stars are due to trouble with the **driving** clock. The slight inequalities of illumination are not real. The **background** should be uniformly dark with the exception of the small, curved **nebula (Dreyer** 6822) near the right edge.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In.	mm.
BD − 8° 5154 . . .	6.2	1855.0	19	46	46.9	− 8	36.1	T	0.2 =	5	R	2.3 =	58
BD − 15° 5516 . . .	5.3	1855.0	19	49	43.7	− 15	52.4	B	2.6	66	R	2.7	69
BD − 14° 5618 . . .	5.8	1855.0	19	53	50.7	− 14	1 7	B	3.8	97	R	3.4	86
BD − 9° 5382 . . .	6.5	1855.0	20	3	18.9	− 9	16.0	T	0.6	15	L	2.0	51
α_2 Capricorni . .	3.8	1855.0	20	10	0.5	− 12	59.1	T	3.1	79	L	1.0	25
BD − 19° 5776 . . .	5.7	1855.0	20	11	1.6	− 19	33.8	B	0.1	3	L	1.0	25
β Capricorni . . .	3	1855.0	20	12	51.8	− 15	13.8	B	2.9	74	L	0.6	15
Dreyer 6822	. . .	1860.0	19	37	3	− 15	6	B	3.0	76	R	0.6	15

PLATE 73

IN SAGITTA

(Top is north) (Scale: 1 cm. = 40′.9)
1855.0 α 19h 56m δ + 19°.6
1894 September 5 Exposure 3h 0m

In the upper half of the picture is the **Dumbbell** Nebula, which appears like a large star.

This is a region of relatively small stars—apparently a large bed or cloud of stars, which, in the upper part of the plate and to the right, assumes structural forms.

Along the right edge, especially in the upper part, the printing is a little light and the feeble illumination is not due to nebulosity.

The relative positions of BD + 14° 4219 and + 14° 4221 do not agree with the BD chart.

Identification of Stars, Etc.

Object.	Mag.	Place.			Distance from Edge of Plate.					
			h m s	° ′		In.	mm.		In.	mm.
BD + 22° 3833	5.7	1855.0	19 44 48.9	+ 22 14.2	T	2.1 =	53	R	1.9 =	48
BD + 23° 3820	4.6	1855.0	19 47 18.1	+ 23 42.0	T	1.1	28	R	2.3	58
BD + 15° 4033	5.0	1855.0	19 56 52.3	+ 15 38.4	B	1.9	48	L	3.2	81
BD + 23° 3896	5.2	1855.0	20 0 39.7	+ 23 11.9	T	1.4	36	L	2.7	69
BD + 14° 4219	7.3	1855.0	20 5 22.9	+ 14 56.5	B	1.5	38	L	1.9	48
BD + 14° 4221	9.0	1855.0	20 5 33.1	+ 14 56.9						
BD + 14° 4227	5.0	1855.0	20 7 33.5	+ 14 45.5	B	1.4	36	L	1.5	38
Dreyer 6853 = M 27 = Dumbbell Nebula . . .	. . .	1860.0	19 53 33	+ 22 20.4	T	2.0	51	R	3.2	81

PLATE 74

IN CYGNUS

(Top is north) (Scale: 1 cm. = 36′.8)
1855.0 α $19^h 58^m$ δ $37^\circ.5$
1892 October 20 Exposure $5^h 0^m$

This is one of the richest parts of the Milky Way. Though not so striking as the wonderful star clouds in **Sagittarius** it is, in some ways, equally interesting.

In the upper left quadrant is γ **Cygni** and its region of nebulosities. Unfortunately, most of these nebulosities are lost in the reproduction.

The northwestern part of the plate is covered with a dense and uniform bed of stars which completely hides the background of the sky and which rather abruptly terminates near the middle of the diagonal from γ **Cygni**.

A striking feature of the picture is the great, darker, parabolic form stretching southwards, near and below the middle of the plate, the edges of which are rather definite and which seems to be a sunken region, farther away from us than the bright region. At the middle of the plate is a sharply defined, flat, triangular spot, some 40 minutes long, in which there are few stars. A straggling, brighter region, containing some much brighter stars, runs southwest from γ to below the middle of the plate. The southeast quadrant seems to be covered with a very thin sheeting of stars through which the background of the sky is visible. Any one interested in the subject, will find in this darker region a remarkable variety of curved lines of stars and vacant lanes.

The "new star" of 1600, P **Cygni**, is shown, as indicated in the list below, a couple of inches to the south of γ **Cygni**.

The small size of the image of the star BD + 39° 4114 ($5^m.4$) shows that the star must be either red or variable.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In.	mm.
BD + 33° 3587 . . .	5.4	1855.0	19	40	56.3	+33	23.6	B	2.7 =	69	R	0.8 =	20
BD + 38° 3817 . . .	5.5	1855.0	19	50	41.3	+38	6.2	T	2.9	74	R	2.3	58
BD + 34° 3798 . . .	4.2	1855.0	19	50	51.8	+34	41.9	B	3.5	89	R	2.2	56
BD + 39° 3968 . . .	5.8	1855.0	19	52	11.0	+39	58.8	T	1.7	43	R	2.5	64
BD + 36° 3806 . . .	5.8	1855.0	19	54	36.1	+36	38.7	T	3.9	99	R	2.7	69
BD + 35° 3930 . . .	7.0	1855.0	19	58	4.7	+35	37.5	B	4.1	104	R	3.2	81
BD + 31° 3925 . . .	6.0	1855.0	19	58	55.2	+31	48.8	B	1.6	41	R	3.2	81
BD + 39° 4114 . . .	5.4	1855.0	20	11	45.4	+39	54.9	T	1.8	46	L	1.8	46
P **Cygni**	Var.	1855.0	20	12	26.1	+37	34.9	T	3.3	84	L	1.7	43
Irregular nebula .	. . .	1855.0	20	12½		+41	30	T	0.8	20	L	1.8	46
γ **Cygni**	2.8	1855.0	20	17	2.2	+39	47.5	T	1.8	46	L	1.2	30
BD + 37° 3916 . . .	6.0	1855.0	20	18	19.0	+37	0.6	T	3.7	94	L	0.9	23
BD + 29° 4057 . . .	4.5	1855.0	20	23	28.9	+29	52.7	B	0.4	10	L	0.1	3
Nebula	. . .	1855.0	20	24		+39	30	T	2.0	51	L	0.4	10

PLATE 75

IN VULPECULA

(Top is north) (Scale: 1 cm. = 37′.4)
1855.0 α 20^h 12^m δ +26°.7
1895 September 20 Exposure 4^h 0^m

There are some cloud-like structures in this region, especially in the upper right quadrant and near the middle of the plate. The reproduction is not as clean cut as it should have been, but in general it is not otherwise defective. The bright patch just below the center is not nebulosity; the stars have been somewhat blurred in the reproduction.

An irregular chain of stars runs nearly across the plate from west to east, passing by the two conspicuous stars below the middle.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In.	mm.
BD + 27° 3587	5.0	1855.0	19	55	8.3	+27	21.1	T	3.2=	81	R	1.3=	33
BD + 31° 3926	6.0	1855.0	19	58	55.2	+31	48.8	T	0.4	10	R	2.0	51
BD + 25° 4165	5.2	1855.0	20	9	7.3	+25	9.0	B	3.7	94	R	3.3	84
BD + 29° 4057	4.2	1855.0	20	23	28.9	+29	52.7	T	1.7	43	L	1.7	43
BD + 31° 4159	6.2	1855.0	20	31	37.9	+31	4.0	T	0.9	23	L	0.6	15
BD + 31° 4160	6.4	1855.0	20	31	38.8	+31	1.0						
BD + 20° 4658	4.7	1855.0	20	32	2.5	+20	41.5	B	0.9	23	L	0.5	13
BD + 23° 4084	5.3	1855.0	20	32	13.2	+23	36.6	B	2.7	69	L	0.5	13
Dreyer 6853 = M27 = Dumbbell Nebula .	. . .	1860.0	19	53	33	+22	20.4	B	2.0	51	R	0.9	23
Dreyer 6885	. . .	1860.0	20	6	7	+26	4.3	T	4.1	104	R	2.8	71
Dreyer 6940	. . .	1860.0	20	28	43	+27	50.1	T	3.0	76	L	1.0	25

PLATE 76

THE NEBULOUS REGION OF γ CYGNI

(Top is north) (Scale: 1 cm. = 44′.1)
1855.0 α $20^h\ 14^m$ δ + 42°.0
1894 June 7 Exposure $4^h\ 17^m$

The immediate vicinity of γ **Cygni**, for several degrees, is filled with patches and masses of nebulosity, some of which are shown on the plate, but most of which have disappeared in the reproduction.

It will be noticed that γ **Cygni** is in a region of considerably brighter stars than the average of the plate. These are especially noticeable southward from that star. P **Cygni** is in one of the brightest patches of stars.

A long exposure photograph of this part of the sky with the 10-inch Bruce telescope of the Yerkes Observatory, shows it to be a most extraordinary region, filled with patches and masses of nebulosity, some of which are very interesting.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In.	mm.
δ **Cygni**	3.0	1855.0	19	40	27.2	+44	46.5	T	1.7=	43	R	0.1=	3
BD+38° 3817 . . .	5.5	1855.0	19	50	41.3	+38	6.2	B	2.5	64	R	0.9	23
BD+34° 3798 . . .	4.2	1855.0	19	50	51.8	+34	41.9	B	0.7	18	R	0.8	20
BD+39° 3968 . . .	5.8	1855.0	19	52	11.0	+39	58.8	B	3.5	89	R	1.1	28
BD+36° 3806 . . .	5.8	1855.0	19	54	36.1	+36	38.7	B	1.7	43	R	1.3	33
BD+35° 3930 . . .	7.0	1855.0	19	58	4.7	+35	37.5	B	1.2	30	R	1.6	41
BD+46° 2881 . . .	5.0	1855.0	20	8	45.7	+46	22.6	T	1.0	25	R	2.8	71
Irregular nebula .	. . .	1855.0	20	12½		+41	30	T	3.7	94	R	3.2	81
P **Cygni**	Var.	1855.0	20	12	26.1	+37	34.9	B	2.2	56	R	3.2	81
γ **Cygni**	2.8	1855.0	20	17	2.2	+39	47.5	B	3.4	86	L	2.8	71
BD+37° 3916 . . .	6.0	1855.0	20	18	19.0	+37	0.6	B	1.9	48	L	2.6	66
Nebula	. . .	1855.0	20	24		+39	30	B	3.2	81	L	2.2	56
α **Cygni**	1.7	1855.0	20	36	30.7	+44	45.6	T	1.8	46	L	1.0	25
Dreyer 6866	. . .	1860.0	19	59	11	+43	36.2	T	2.4	61	R	1.9	48

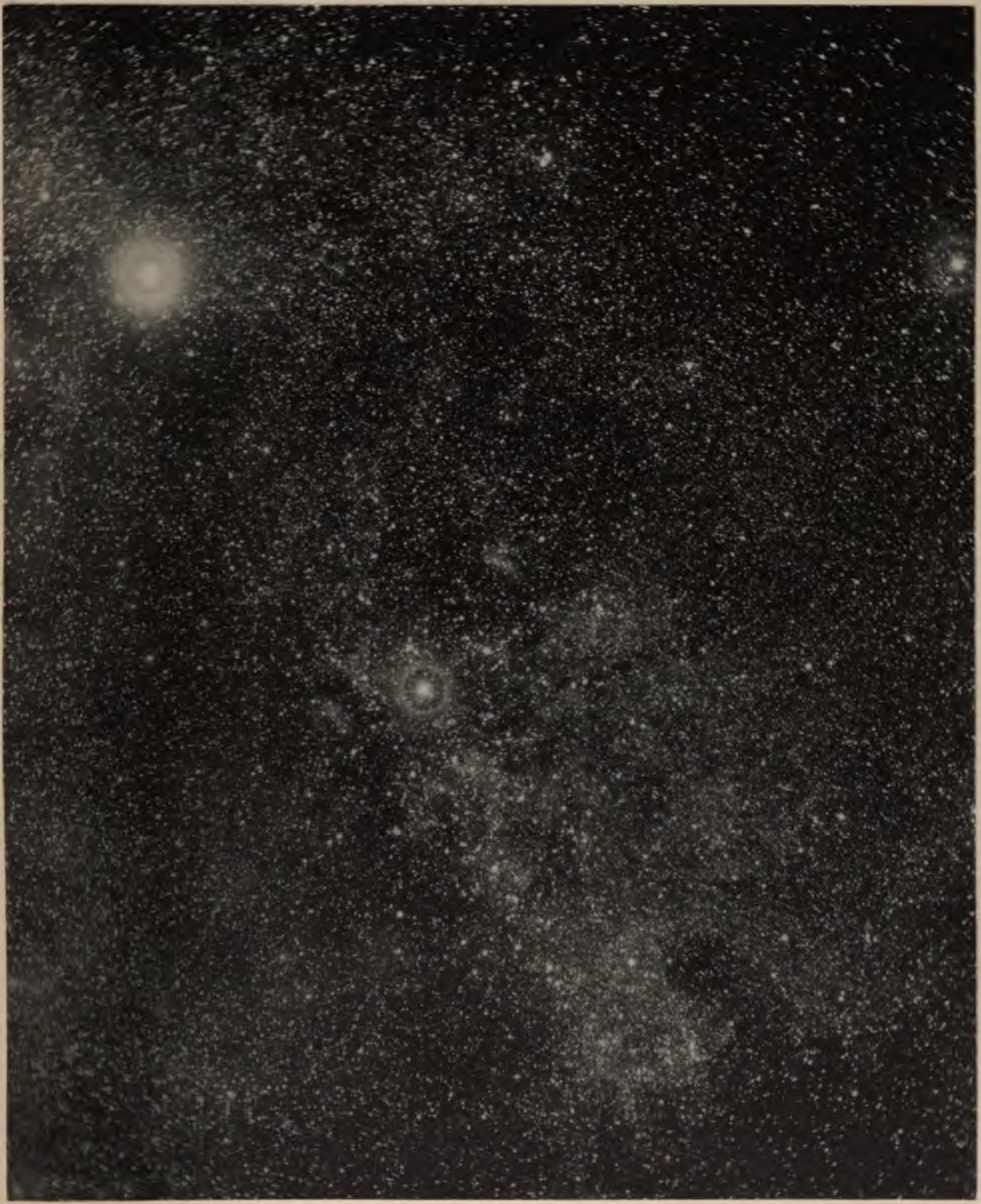

PLATE 77

REGION OF THE NORTH AMERICA NEBULA (H V 37 Cygni)

(Top is north) (Scale: 1 cm. = $38'.0$)
1855.0 α $20^h\ 38^m$ δ $+45^\circ.5$
1894 October 3 Exposure $3^h\ 15^m$

The star α **Cygni** occupies the middle of the picture. To the left is the great nebula Herschel V 37 = Dreyer 7000. This remarkable object was discovered by Wm. Herschel, who saw it as a diffused nebulosity in the Milky Way. The first photographs of it which showed its singular form, were made by Dr. Max Wolf, who happily named it the "North America Nebula." The almost vacant region south and west of it is covered with patches of this nebulous matter that are mostly lost in the reproduction, and which, in a fainter form, perhaps, extend to and connect with the nebulosities about γ **Cygni**, which are shown in the lower right corner. This great nebula, as will be seen, is on the abrupt end of a flat square-shaped mass of stars that extends for some degrees northwards, and is broken on each side by peculiar dark indentations. From the close association of the nebula with the end of this mass of stars, one would infer that they are actually connected, but the nebulosity shows no tendency to condense about any of the stars. This, however, is not surprising, for we have numerous instances where stars and nebulosity apparently freely mix without any individual condensation.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.			Distance from Edge of Plate.					
			h m s	° ′		In	mm.		In.	mm.
BD + 46° 2881 . . .	5.0	1855.0	20 8 45.7	+ 46 22.6	T	3.0 =	76	R	0.3 =	8
γ **Cygni**	2.8	1855.0	20 17 2.2	+ 39 47.5	B	0.5	13	R	0.9	23
BD + 48° 3142 . . .	4.9	1855.0	20 25 34.9	+ 48 28.2	T	1.7	43	R	2.1	53
α **Cygni**	1.7	1855.0	20 36 30.7	+ 44 45.6	B	3.5	89	R	3.3	84
BD + 49° 3353 . . .	5.7	1855.0	20 37 44.6	+ 49 49.3	T	0.9	23	R	3.4	86
BD + 43° 3755 . . .	5.4	1855.0	20 48 7.7	+ 43 50.3	B	3.0	76	L	2.4	61
BD + 40° 4364 . . .	4.0	1855.0	20 51 46.6	+ 40 36.7	B	1.0	25	L	1.9	48
BD + 49° 3426 . . .	5.5	1855.0	20 53 51.7	+ 49 54.2	T	0.8	20	L	2.0	51
BD + 46° 3133 . . .	5.3	1855.0	20 54 53.8	+ 46 57.4	T	2.6	66	L	1.8	46
BD + 45° 3364 . . .	5.7	1855.0	20 56 7.1	+ 45 35.3	T	3.5	89	L	1.6	41
Dreyer 6991	. . .	1860.0	20 49 52	+ 46 44.6	T	2.7	69	L	2.2	56

PLATE 78

IN CYGNUS—REGION OF THE NORTH AMERICA NEBULA

(Top is north) (Scale: 1 cm. = 43′.7)
1855.0 α $20^h\ 57^m$ δ 42°.6
1893 October 5 Exposure $6^h\ 5^m$

This plate perhaps shows this general region better than Plate 77. The masses of nebulosity in the vacant space west of the North America Nebula are better shown. The great nebula itself is a striking feature.

The sheeting of stars in the lower and left part of the plate seems to be of a more or less streaky nature in parts, as if some general trend of streams of stars in that region were indicated. I have noticed this peculiarity in many parts of the Milky Way, some of which are more marked than in this case. The general impression is that all the stars in each of these "flows," if we can so call them, are drifting in some general direction.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In.	mm.
α **Cygni**	1.7	1855.0	20	36	30.7	+44	45.6	T	1.8=	46	R	0.9=	23
BD+43°3755	5.4	1855.0	20	48	7.7	+43	50.3	T	2.4	61	R	2.0	51
BD+40° 4364	4.0	1855.0	20	51	46.6	+40	36.7	B	2 7	69	R	2.3	58
BD+46° 3133	5.3	1855.0	20	54	53.8	+46	57.4	T	0.7	18	R	2.7	69
BD+45° 3364	5.7	1855.0	20	56	7.1	+45	35.3	T	1.4	36	R	2.8	71
BD+43° 3800	4.0	1855.0	20	59	40.7	+43	21.1	T	2.7	69	L	2.9	74
61 **Cygni**	5.0	1855.0	21	0	24.5	+38	2 5	B	1.3	33	L	2.8	71
BD+37° 4240	4.0	1855.0	21	7	59.8	+37	25.3	B	1.0	25	L	1.9	48
BD+43° 3877	5.3	1855.0	21	13	3.9	+43	20.2	T	2.7	69	L	1.6	41
BD+36° 4568	5.0	1855.0	21	21	26.0	+36	29.5	B	0.5	13	L	0.5	13
Dreyer 6991	...	1860.0	20	4	52	+46	44.6	T	0.7	18	R	2.3	58

PLATE 79

IN CYGNUS—BETWEEN ϵ AND λ CYGNI

(Top is north) (Scale: 1 cm. = 37′.1)

1855.0 α $20^h 42^m$ δ +34°.8

1894 September 25 Exposure $5^h 20^m$

In the lower part of the plate are the two singular nebulosities Dreyer 6960 and 6995. Between them is an intricate system of nebulous strips and patches that seems to connect the two main masses.

There is a rather dark region running down to the right of the middle of the plate and broadening out into a wider space in the lower right quadrant to the right of Dreyer 6960.

In the upper part of the photograph some singular curved vacant lanes can be made out among the stars. **Gamma Cygni**, and its nebulous region, occupies the upper right corner.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.			Distance from Edge of Plate.					
			h m s	° ′		In.	mm.		In.	mm.
γ Cygni	2.8	1855.0	20 17 2.2	+39 47.5	T	0.3 =	8	R	0.3 =	8
BD + 29° 4057 . . .	4.2	1855.0	20 23 28.9	+29 52.7	B	1.7	43	R	0.8	20
BD + 31° 4159 . . .	6.2	1855.0	20 31 37.9	+31 4.0	B	2.4	61	R	2.0	51
BD + 31° 4160 . . .	6.4	1855.0	20 31 38.8	+31 1.0						
BD + 30° 4167 . . .	4.3	1855.0	20 39 40.0	+30 11.3	B	1.8	46	R	3.1	79
BD + 33° 4018 . . .	2.6	1855.0	20 40 21.1	+33 25.4	B	4.0	102	R	3.2	81
BD + 35° 4267 . . .	4.7	1855 0	20 41 46.7	+35 57.7	T	2.9	74	R	3.4	86
61 Cygni	5.0	1855 0	21 0 24.5	+38 2.5	T	1.5	38	L	1.4	36
BD + 29° 4348 . . .	3.0	1855.0	21 6 46.3	+29 37.8	B	1.6	41	L	0.2	5
BD + 37° 4240 . . .	4.0	1855.0	21 8 59.8	+37 25.3	T	1.9	48	L	0.3	8
Dreyer 6940	. . .	1860.0	20 28 43	+27 50.1	B	0.3	8	R	1.5	38
Dreyer 6960	. . .	1860.0	20 39 53	+30 12.8	B	1.8	46	R	3.1	79
Dreyer 6995	. . .	1860.0	20 51 20	+30 40.7	B	2½	64	L	2½	64

DEFECTS

Description.	Distance from Edge of Plate.					
		In.	mm.		In.	mm.
White, irregular	B	0.1 =	3	L	0.6 =	15

PLATE 80

THE NEBULÆ DREYER 6960 AND 6995 (ENLARGED)

(Top is east) (Scale: 1 cm. = 20′.9)
1855.0 α 20^h 42^m δ +31°.0
1894 September 25 Exposure 5^h 20^m

This enlargement shows fairly well the relative positions of these two singular nebulæ. Some of the irregular nebulosities between them are also shown, but the plate is printed too dark for the fainter ones. Long exposure plates with the Bruce 10-inch telescope of the Yerkes Observatory, almost fill the space between the brighter nebulæ with wispy masses of nebulosity which seem to connect the two.

Dr. Dreyer, in N. G. C., identifies the bright star (BD + 30° 4167) in the nebula 6960 as "κ **Cygni**." This is erroneous. It is 52 **Cygni**—the star **Kappa** being some 25 degrees to the northwest of the nebula, according to Proctor's Chart and the Greenwich Ten Year Catalog of 6892 Stars for 1890.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.			Distance from Edge of Plate.					
			h m c	° ′		In.	mm.		In.	mm.
BD+31° 4159 . . .	6.2	1855.0	20 31 37.9	+31 4.0	B	1.4	=36	R	2.5	=64
BD+31° 4160 . . .	6.4	1855.0	20 31 38.8	+31 1.0						
BD+30° 4167 . . .	4.3	1855.0	20 39 40.0	+30 11.3	B	3.3	84	L	3.0	76
BD+31° 4217 . . .	7.2	1855.0	20 40 54.3	+31 53.4	B	3.7	94	R	1.6	41
BD+32° 3974 . . .	6.7	1855.0	20 46 6.7	+32 18.1	T	3.1	79	R	1.2	30
BD+31° 4254 . . .	6.7	1855.0	20 47 33.7	+31 5.0	T	2.8	71	R	2.6	66
BD+27° 3909 . . .	7.0	1855.0	20 48 13.2	+27 58.3	T	2.6	66	L	0.4	10
BD+31° 4292 . . .	7.0	1855.0	20 52 42.7	+31 5.4	T	1.5	38	R	2.5	64
Dreyer 6940	. . .	1860.0	20 28 43	+27 50.1	In lower left corner					

PLATE 81

IN CYGNUS—NEAR π CYGNI

(Top is north) (Scale: 1 cm. = 36′.2)
1855.0 α $21^h 41^m$ δ +50°.0
1895 September 22 Exposure $4^h 15^m$

The plate is quite free of defects with the exception of a very small black spot near the right edge, which will deceive no one.

The structure of the Milky Way is well shown here. Below the middle and slightly to the left is a small nebula at the end of a dark channel, which runs west for about 90 minutes of arc. This object is shown on one of my plates made 1893 October 11 (see *Ap. J.* **21**, 47, 1905). Dr. Max Wolf has given a photograph of the nebula in *M. N.* **64**, 838, 1903–4, which was made 1904 July 10.

The stars of this part of the Milky Way seem to be very small. There are some small vacant spots near the middle right edge, respectively one half inch, and one inch above the small black defect. There are also some irregular dark structures just above the middle of the plate. Another broad dusky streak runs upwards diagonally to the left from the dark lane referred to.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.			Distance from Edge of Plate.					
			h m s	° ′		In.	mm.		In	mm.
BD+48° 3345	5.4	1855.0	21 14 30.0	+48 53.9	B	3.2 =	81	R	0.2 =	5
Dark hole	. . .	1855.0	21 19 0	+49 35	B	3.6	91	R	0.7	18
BD+49° 3517	9.0	1855.0	21 19 51.5	+49 36.6	B	3.6	91	R	0.7	18
BD+50° 3410	5.1	1855.0	21 36 56.3	+50 31.5	T	3.1	79	R	2.6	66
BD+48° 3504	4.5	1855.0	21 41 26.1	+48 38.3	B	2.9	74	R	3.0	76
BD+55° 2639	6.0	1855.0	21 47 8.2	+55 7.1	T	0.1	3	L	2.6	66
BD+52° 3083	5.3	1855.0	21 56 32.5	+52 11.0	T	2.0	51	L	1.6	41
BD+50° 3602	6.0	1855.0	22 5 32.9	+50 6.6	T	3.3	84	L	0.6	15
Dreyer *2d Index Catalog* 5146	. . .	1860.0	21 48 6	+46 36.3	B	1.6	41	L	2.3	58

DEFECTS

Description.	Distance from Edge of Plate.					
		In.	mm		In.	mm.
Small, black	B	3.0 =	76	R	0.6 =	15

PLATE 82

NEBULOUS REGION IN CEPHEUS

(Top is north) (Scale: 1 cm. = 36′.8)

1855.0 α $21^h\ 44^m$ δ $+58^\circ.0$

1893 October 13 Exposure $7^h\ 0^m$

The main feature in this plate is the large nebulous cluster a little south and west of the middle of the picture. The nebulosity is remarkable for the irregular dark lanes that ramify it in various directions—especially to the north and southwest. There are three sets of these lanes, each one leading to a semi-vacant region of the adjacent sky. The irregular vacancy about one degree square, at the lower part of the nebula is sharply defined at its edges and resembles somewhat the vacancies northwest of **Altair** (Plate 69). This spot sends up an irregular dark channel through the western part of the nebula for nearly two degrees. There is no tendency of this nebulosity to condense about the stars, which are apparently in it.

There is a black spot 3.3 inches from the top and 2.8 inches from the left, that has a small island of stars in it. The bright star in the upper right corner is α **Cephei**.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.			Distance from Edge of Plate.					
			h m s	° ′		In	mm.		In.	mm.
BD + 57° 2309 . . .	6.5	1855.0	21 13 21.1	+ 57 58.9	T	3.2	= 81	L	1.0	= 25
α **Cephei**	3.0	1855.0	21 15 10	+ 61 58.4	T	0.7	18	R	1.4	36
BD + 54° 2544 . . .	6.1	1855.0	21 24 19.8	+ 54 47.2	B	2.4	61	R	1.8	46
BD + 56° 2617 . . .	6.2	1855.0	21 34 29.8	+ 56 49.7	B	3.7	94	R	2.8	71
BD + 57° 2374 . . .	7.2	1855.0	21 37 53.0	+ 57 4.7	B	3.8	97	R	3.1	79
BD + 60° 2288 . . .	4.5	1855.0	21 41 17.3	+ 60 26.2	T	1.8	46	R	3.4	86
BD + 55° 2639 . . .	6.0	1855.0	21 47 8.2	+ 55 7.1	T	2.6	66	L	3.3	84
BD + 52° 3083 . . .	5.3	1855.0	21 56 32.5	+ 52 11.0	B	0.7	18	L	2.3	58
BD + 57° 2441 . . .	6.4	1855.0	21 57 12.0	+ 57 18.0	T	3.8	97	L	2.5	64
BD + 57° 2475 . . .	4.1	1855.0	22 5 49.6	+ 57 29.3	T	3.6	91	L	1.7	43
BD + 58° 2402 . . .	5.6	1855.0	22 6 37.7	+ 58 41.8	T	2.8	71	L	1.7	43
BD + 57° 2548 . . .	Var.	1855.0	22 23 49.1	+ 57 40.9	T	3.3	84	L	0.2	5

PLATE 83

IN CEPHEUS—NORTHEAST OF α CEPHEI

(Top is north) (Scale: 1 cm. = 36′.9)
1855.0 α 22^h 0^m δ +65°.4
1895 September 24 Exposure 5^h 0^m

Some of the prints of this plate have a triangular-shaped, slightly luminous defect in the lower half of the picture an inch or more in diameter. There is no diffused nebulosity shown on the plate. The bright star in the lower right edge of the picture is α Cephei.

Evidently much structure would show here with a still longer exposure, as there are indications of a bed of very faint stars to the east of α Cephei and a partially vacant region in the east half of the plate. The star BD + 67° 1332 is nebulous.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.			Distance from Edge of Plate.					
			h m s	° ′		In.	mm.		In.	mm.
α **Cephei**	3.0	1855.0	21 15 10	+61 58.4	B	3.2 =	81	R	0.3 =	8
BD + 67° 1329 . . .	6.8	1855.0	21 32 48	+67 34.2	T	1.5	38	R	2.0	51
BD + 67° 1332 . . .	8.3	1855.0	21 34 12	+67 32.0	T	1.5	38	R	2.1	53
BD + 64° 1607 . . .	6.5	1855.0	21 51 42	+64 38.8	B	3.6	91	R	3.1	79
BD + 63° 1802 . . .	4.5	1855.0	21 59 36	+63 54.9	B	3.2	81	R	3.6	91
BD + 62° 2102 . . .	5.3	1855.0	22 33 31	+62 49.7	B	2.6	66	L	1.0	25
BD + 65° 1814 . . .	3.8	1855.0	22 44 32	+65 25.9	T	2.7	69	L	0.5	13
Dreyer 7023	. . .	1860.0	20 59 51	+67 36.7	T	1.1	28	R	0.0	0
Dreyer 7142	. . .	1860.0	21 42 34	+65 9.3	T	3.1	79	R	2.4	61

PLATE 84

IN CEPHEUS

(Top is north) (Scale: 1 cm. = 44′.1)
1855.0 α 22h 7m δ +53°.2
1893 October 11 Exposure 6h 21m

This is a rich region of small stars, but the plate has been printed a little too dark and so has lost some of the cloud effects in the upper and western part of the picture. The great nebula shown in Plate 82 should occupy the upper right corner of the present plate. The cluster of stars is shown but the nebulosity is lost in reproduction.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.			Distance from Edge of Plate.					
			h m s	° ′		In	mm		In.	mm.
BD+48° 3504 . . .	4.5	1855.0	21 41 26.1	+48 38.3	B	1.6	=41	R	1.1	=28
BD+55° 2639 . . .	6.0	1855.0	21 47 8.2	+55 7.1	T	2.4	61	R	1.9	48
BD+52° 3083 . . .	5.3	1855.0	21 56 28.0	+52 14.7	B	3.5	89	R	2.5	64
BD+57° 2441 . . .	6.4	1855.0	21 57 12.0	+57 18.0	T	1.2	30	R	2.7	69
BD+46° 3719 . . .	4.8	1855.0	22 23 30.1	+46 57.9	B	0.6	15	L	1.3	33
BD+57° 2548 . . .	Var.	1855.0	22 23 49.1	+57 40.9	T	1.0	25	L	1.5	38
BD+49° 3875 . . .	4.0	1855.0	22 25 19.3	+49 32.2	B	2.0	51	L	1.2	30
Dreyer 7243	. . .	1860.0	22 9 41	+49 11.1	B	1.8	46	L	2.6	66
Dreyer 7380	. . .	1860.0	22 41 23	+57 20.9	T	1.1	28	L	0.2	5

PLATE 85

IN CEPHEUS

(Top is north) (Scale: 1 cm. = 37′.4)
1855.0 α 22^h 44^m δ +53°.7
1895 September 25 Exposure 6^h 0^m

The brightness of the star masses in the upper right side of the plate has been somewhat accentuated in the reproduction.

If the middle and lower half of the picture are carefully examined, a great many vacant lanes and lines of stars will be found. The upper part of the great bed of small stars covering nearly the whole plate, assumes cloud form effects where it opens on to a poorer region in which the small stars, especially, are absent.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.						Distance from Edge of Plate.					
			h	m	s	°	′		In.	mm.		In	mm.
BD+57° 2548 . . .	Var.	1855.0	22	23	49.1	+57	40.9	T	1.8=	46	R	2.1=	53
BD+49° 3875 . . .	4.0	1855.0	22	25	19 3	+49	32.2	B	2.4	61	R	1.8	46
BD+53° 2993 . . .	6.0	1855.0	22	42	47.4	+53	39.2	T	4.5	114	R	3.6	91
BD+47° 3985 . . .	5.3	1855.0	22	50	40.2	+47	54.3	B	1.2	30	L	3.1	79
BD+58° 2545 . . .	5.3	1855.0	23	0	29.8	+58	38.5	T	1.3	33	L	2.3	58
BD+48° 3964 . . .	5.0	1855.0	23	5	59.1	+48	36.7	B	1.7	43	L	1.5	38
BD+57° 2748 . . .	5.7	1855.0	23	23	23 4	+57	45.8	T	1.7	43	L	0.4	10
Dreyer 7380	. . .	1860.0	22	41	23	+57	20.9	T	2.1	53	R	3 6	91

PLATE 86

IN CASSIOPEIA

(Top is north) (Scale: 1 cm. = $43'.7$)
1855.0 α $23^{h}\ 7^{m}$ δ $+59^{\circ}\ 0$
1895 July 17 Exposure $4^{h}\ 20^{m}$

Diagonally across the middle of the plate is a bridge of small stars with thinner regions on each side especially to the north. Many of these stars seem to be exceedingly minute where they are scattered over the dark region to the left.

There is a small star close following BD + 64° 1664, which is not in the BD catalog nor on the chart.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.			Distance from Edge of Plate.					
			h m s	° ′		In.	mm.		In.	mm.
BD + 64° 1664 . . .	5.8	1855.0	22 22 26	+64 23	T	0.3 =	8	R	0.6 =	15
BD + 57° 2548 . . .	Var.	1855.0	22 23 49.1	+57 40.9	B	3.5	89	R	0.2	5
BD + 62° 2102 . . .	5.3	1855.0	22 33 31	+62 49.7	T	1.2	30	R	1.1	28
BD + 53° 2993 . . .	6.0	1855.0	22 42 47.4	+53 39.2	B	1.2	30	R	1.4	36
BD + 58° 2545 . . .	5.3	1855.0	23 0 29.8	+58 38.5	T	3.6	91	R	2.8	71
BD + 60° 2522 . . .	8.0	1855.0	23 14 19.6	+60 23.8	T	2.7	69	L	2.5	64
Dreyer 7635	. . .	Nebula involving above star								
BD + 57° 2748 . . .	5.7	1855.0	23 23 23.4	+57 45.8	B	3.5	89	L	1.8	46
BD + 52° 3503 . . .	6.5	1855.0	23 36 4.0	+52 20.8	B	0.7	18	L	0.5	13
Dreyer 7380	. . .	1860.0	22 41 23	+57 20.9	B	3.2	81	R	1.4	36
Dreyer 7654 = M 52	. . .	1860.0	23 18 3	+60 49.7	T	2.4	61	L	2.3	58

PLATE 87

In Cassiopeia

(Top is north) (Scale: 1 cm. = 38′.0)
1855.0 α 23ʰ 39ᵐ δ +62°.6
1895 September 27 Exposure 4ʰ 0ᵐ

This is nearly the same region as Plate 86. The general structure of the sky, however, is better brought out in this plate. There is evidence of much dark structure in the lower part of the picture, below the bridge of stars.

A luminous defect appears in some of the prints in the upper half of the plate. There is no diffused nebulosity shown in this region.

The star BD + 62° 2310 ($6^m.9$) is very faint on the photograph, and is probably either red or variable.

Identification of Stars, Etc.

Object.	Mag.	Place.			Distance from Edge of Plate.					
			h m s	° ′		In.	mm.		In.	mm.
BD+65° 1814 . . .	3.8	1855.0	22 44 32	+65 25.9	T	0.9	=23	R	0.1	= 3
BD+58° 2545 . . .	5.3	1855.0	23 0 29.8	+58 38.5	B	1.8	46	R	0.5	13
BD+60° 2522 . . .	8.0	1855.0	23 14 19.6	+60 23.8	B	2.75	70	R	1.75	44
Dreyer 7635	. . .	Nebula involving above star								
BD+57° 2748 . . .	5.7	1855.0	23 23 23.4	+57 45.8	B	1.0	25	R	2.3	58
BD+63° 2051 . . .	7.0	1855.0	23 39 36	+63 29.6	T	2.6	66	L	3.45	88
BD+63° 2054 . . .	7.2	1855.0	23 40 25	+63 19.8	T	2.7	69	L	3.4	86
BD+67° 1562 . . .	5.5	1855.0	23 41 3	+67 0.0	T	0.4	10	L	3.3	84
BD+62° 2310 . . .	6.9	1855.0	23 43 21	+62 56.3	T	2.9	74	L	3.2	81
BD+63° 2064 . . .	6.6	1855.0	23 43 56	+63 10.7	T	2.8	71	L	3.2	81
BD+63° 2107 . . .	5.4	1855.0	23 58 58	+63 22.2	T	2.6	66	L	2.1	53
β Cassiopeiæ . .	2.2	1855.0	0 1 29.6	+58 21.0	B	1.4	36	L	1.7	43
BD+65° 67	6.5	1855.0	0 23 9	+65 43.2	T	1.0	25	L	0.6	15
Dreyer 7654 = M 52	. . .	1860.0	23 18 3	+60 49.7	B	3.0	76	R	2.1	53

PLATE 88

IN CASSIOPEIA

(Top is north) (Scale: 1 cm.=37′.1)
1855.0 α 23^{h} 10^{m} δ +53°.7
1895 September 28 Exposure 3^{h} 0^{m}

There are indications that a much longer exposure here would show considerable structure, especially in the upper part of the plate. The partially luminous places near the edges are not real. There are no nebulosities shown in this picture.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.			Distance from Edge of Plate.					
			h m s	° ′		In.	mm.		In.	mm.
BD+53° 2993 . . .	6.0	1855.0	22 42 47.4	+53 39.2	T	3.1	=79	R	1.0	=25
BD+58° 2545 . . .	5.3	1855.0	23 0 29.8	+58 38.5	T	0.1	3	R	2.9	74
BD+48° 3964 . . .	5.0	1855.0	23 5 59.1	+48 36.7	B	1.2	30	R	3.1	79
BD+52° 3410 . . .	5.4	1855.0	23 10 7.6	+52 26.3	B	3.6	91	R	3.6	91
BD+57° 2748 . . .	5.7	1855.0	23 23 23.4	+57 45.8	T	0.7	18	L	2.6	66
BD+49° 4180 . . .	5.7	1855.0	23 32 7.6	+49 40.1	B	1.9	48	L	1.5	38
Dreyer 7789	. . .	1860.0	23 49 59	+55 56.2	T	1.7	43	L	0.2	5

DEFECTS

Description.	Distance from Edge of Plate.					
		In.	mm.		In.	mm.
Like a faint cluster of stars	T	3.4	=86	L	0.5	=13
Like a faint cluster of stars	T	2.9	74	L	0.1	3

PLATE 89

REGION OF β CASSIOPEIÆ

(Top is north) (Scale: 1 cm. = 37′.1)
1855.0 α 23h 54m δ +59°.3
1894 September 27 Exposure 3h 5m

Considerable structure exists in this region which could be brought out stronger with a longer exposure. This plate, however, gives a fair idea of what this structure is. The haze around β **Cassiopeiæ**, near the middle of the picture, is due to halation. The region is part of that shown in Plates 86 and 87, where the structure of this part of the sky is somewhat better shown.

IDENTIFICATION OF STARS, ETC.

Object.	Mag.	Place.			Distance from Edge of Plate.		
			h m s	° ′		In. mm.	In. mm.
BD + 57° 2748 . . .	5.7	1855.0	23 23 23.4	+57 45.8	B	3.2 = 81	R 0.9 = 23
β **Cassiopeiæ** . .	2.2	1855.0	0 1 29.6	+58 21.0	B	3.3 84	L 3.1 79
BD + 53° 105	4.1	1855.0	0 28 56.0	+53 5.9	B	0.1 3	L 0.5 13
BD + 55° 139	Var.	1855.0	0 32 18.8	+55 44.6	B	1.8 46	L 0.3 8
Dreyer 7654 = M 52	. . .	1860.0	23 18 3	+60 49.7	T	2.1 53	R 0.7 18
Dreyer 7789	. . .	1860.0	23 49 50	+65 56.2	B	1.8 46	R 3.1 79

DEFECTS

Description.	Distance from Edge of Plate.	
	In. mm.	In. mm.
Like a small, round nebula	B 3.2 = 81	R 0.7 = 18

PLATE 90

COMET I 1892 (SWIFT)

(Left is north) (Scale: 1 cm. = 19′.1)
1855.0 α 21^h 2^m δ −3°.2
1892 April 4^d 15^h 57^m P.S.T. Exposure 1^h 5^m

In this plate there are some inequalities of illumination which will not deceive any one, as the main features of the comet are clearly and strongly shown. The edges of the separate streamers are very sharply defined, and the rifts between them apparently have very little nebulosity in them.

PLATE 91

COMET I 1892 (SWIFT)

(Left is north) (Scale: 1 cm. = 23′.6)

1855.0 α $21^h 6^m$ δ $-2^\circ.2$

1892 April 5^d $16^h 20^m$ P.S.T. Exposure $0^h 30^m$

The original plate was in a rather poor condition, but the defects are readily made out and do not materially interfere with the tail. The two intensifications of luminosity in the tail, respectively 2.7 inches and 4 inches from the head, are perhaps not real.

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PLATE 92

COMET I 1892 (SWIFT)

(Left is north) (Scale: 1 cm. = 27′.2)
1855.0 α 21ʰ 10ᵐ δ − 1°.0
1892 April 6ᵈ 16ʰ 2ᵐ P.S.T. Exposure 1ʰ 5ᵐ

This is a good reproduction and shows the features of the tail clearly. The great change in the appearance of the tail in the 24 hours is very marked. It would be dangerous to attempt to identify any features in this plate and the one of November 5, but there is, perhaps, some association of the bend in the near end of the great rift, with the mass shown in Plate 93 of the succeeding date.

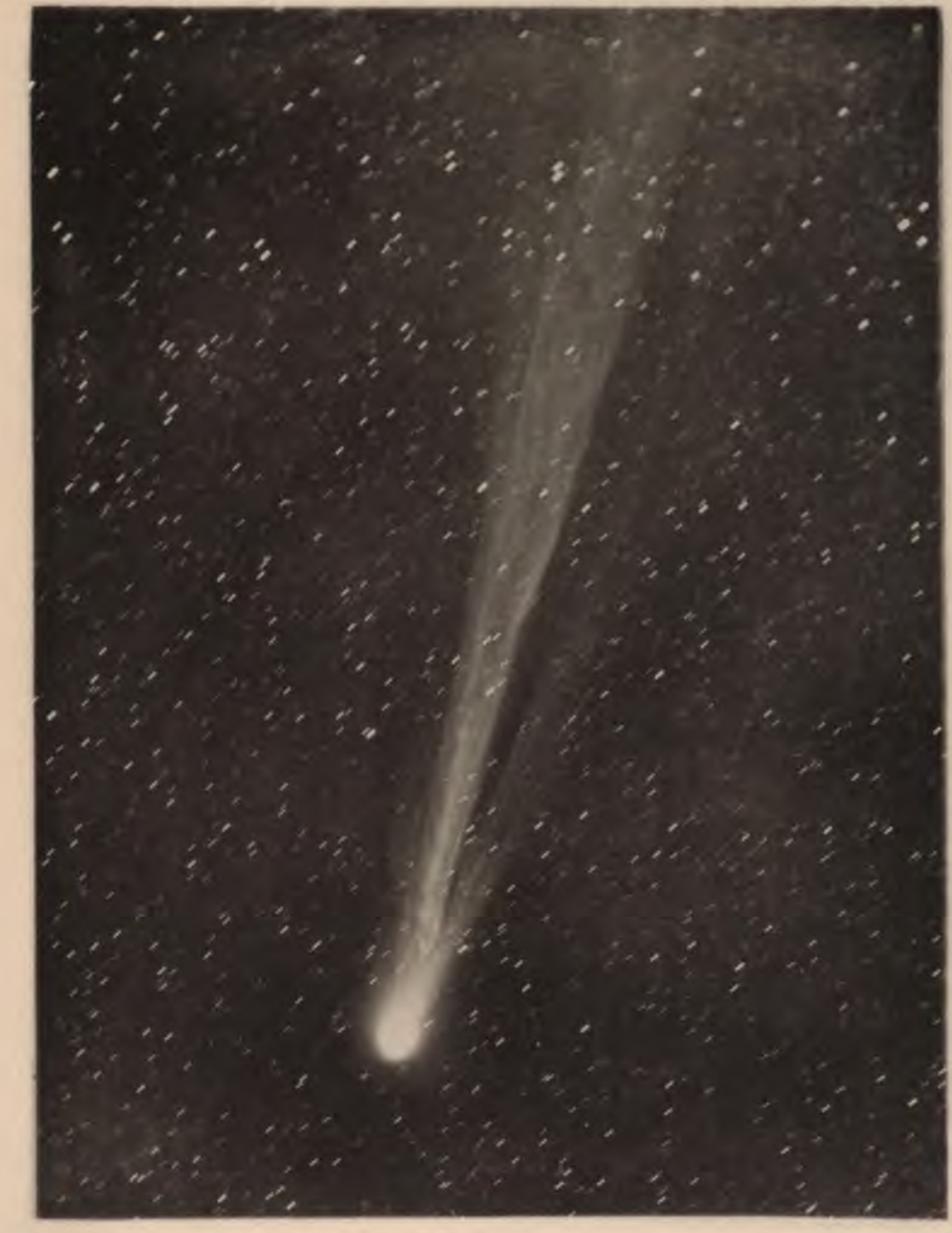

PLATE 93

COMET I 1892 (SWIFT)

(Left is north) (Scale: 1 cm. = 21′.0)
1855.0 α 21^h 13^m δ 0°.0
1892 April 7^d 16^h 10^m P.S.T. Exposure 0^h 50^m

The remarkable appearance of the tail in this plate does not suggest any connection with the tail on November 6, but possibly the great mass is in some way related to the bend in the rift near the head on that date. The luminous spot farther along near the end of the tail is a defect.

The picture has suffered greatly from the accentuation of irregularities of illumination of the plate in the reproduction, but the main features of the tail are unmistakable.

PLATE 94

COMET I 1892 (SWIFT)

(Left is north) (Scale: 1 cm. = 39′.0)

1855.0 α 21^h 52^m δ +10°.6

1892 April 18^d 15^h 0^m P.S.T. Exposure 0^h 30^m

Much of the tail has been lost in the reproduction. It is really made up of a bundle of slightly diverging rays.

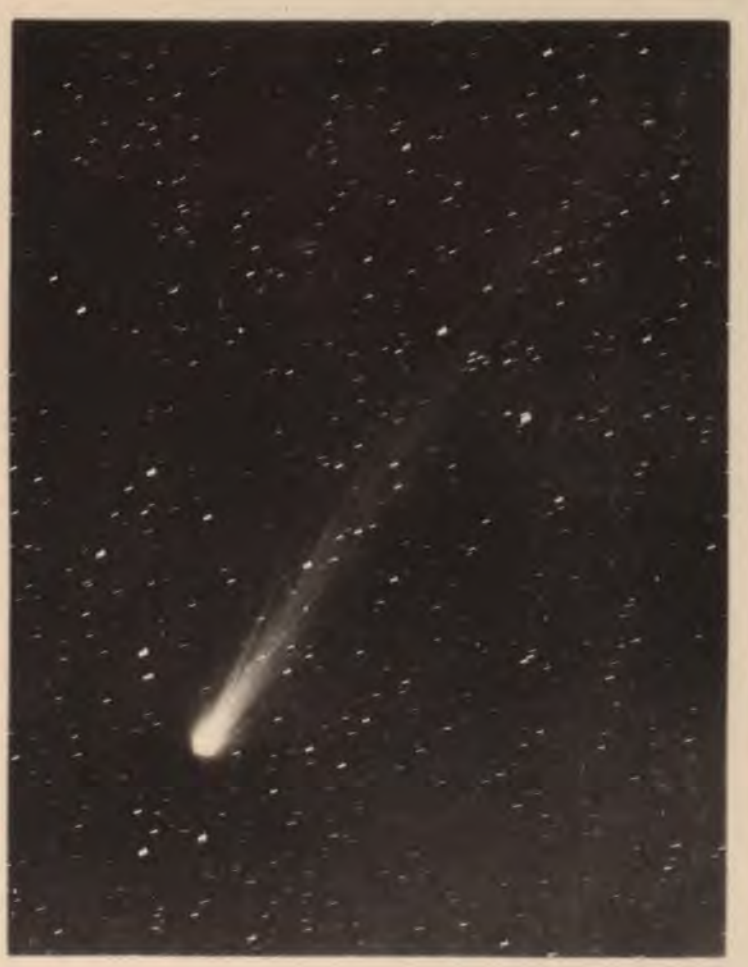

PLATE 96

COMET I 1892 (SWIFT)

(Left is north) (Scale: 1 cm. = 37′.8)

1855.0 α 22h 11m δ + 15°.7

1892 April 24d 15h 0m P.S.T. Exposure 2h 20m

Much of the tail is lost in the reproduction, which is printed too dark. Enough remains, however, to show the structure near the head.

PLATE 97

COMET I 1892 (SWIFT)

(Left is north) (Scale: 1 cm. = 18′.7)

1855.0 α 22^{h} 18^{m} δ +17°.3

1892 April 26^{d} 14^{h} 57^{m} P.S.T. Exposure 2^{h} 25^{m}

Unfortunately, a defect in the original cuts off the larger part of the tail. Beyond this defect the tail is visible to the edge of the original plate and also partly through the defect itself. The tail consists of several slightly diverging streams.

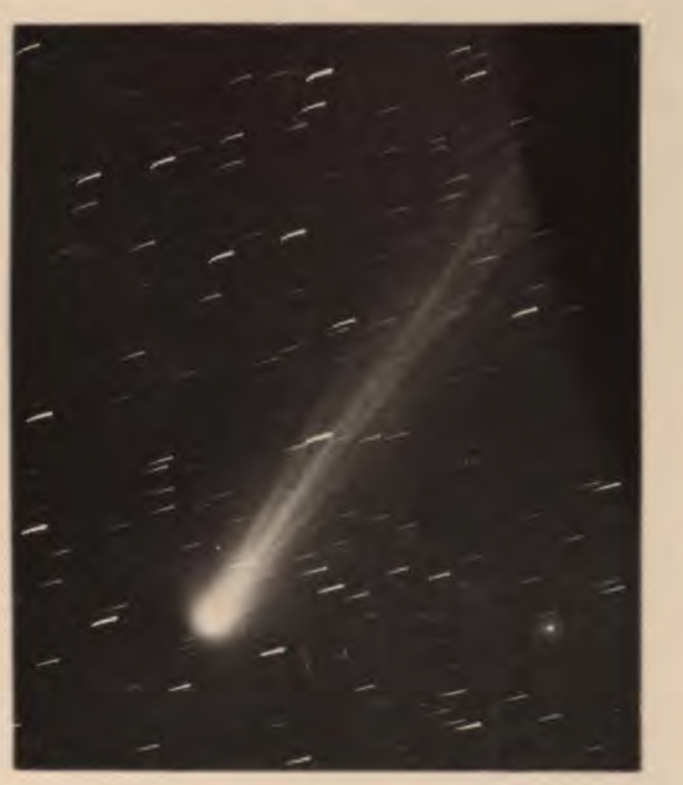

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PLATE 98

COMET I 1892 (SWIFT)

(Left is north) (Scale: 1 cm = 22'.3)

1855.0 α 23^h 31^m δ $-33^\circ 5$

1892 May 22^d 14^h 10^m P.S.T. Exposure 2^h 0^m

There is not much of interest in this plate. Some slight inequalities appear in the tail near the head, while several incipient streamers are shown on the north side.

PLATE 99

COMET I 1892 (SWIFT)

(Left is north) (Scale: 1 cm. = 26′.3)

1855.0 α $23^h\ 33^m$ δ $+33^\circ.8$

1892 May 23^d $14^h\ 9^m$ P.S.T. Exposure $2^h\ 2^m$

The large luminosity which covers the greater part of the middle of the plate is a defect. The tail, however, is clearly shown through its full extent and need in no way be confused with the general illumination of the plate.

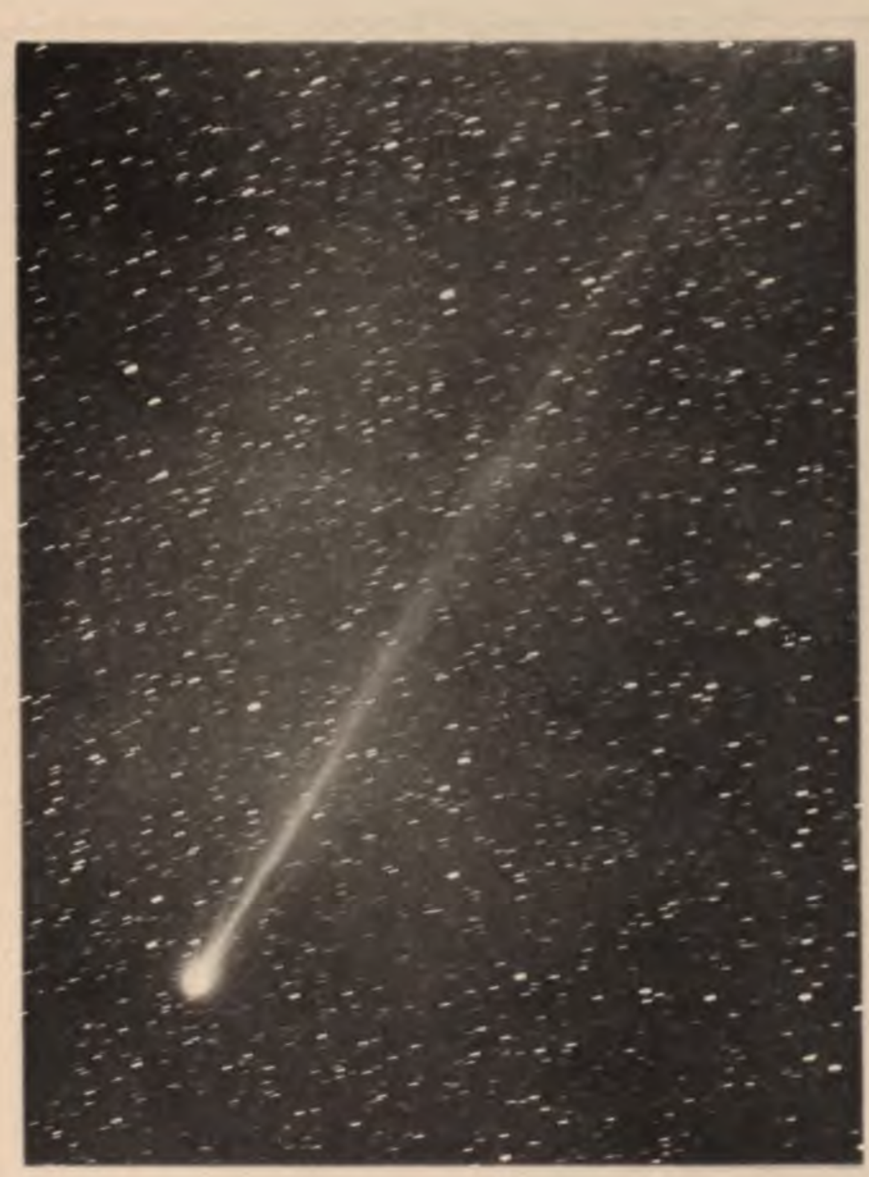

PLATE 100

COMET I 1892 (SWIFT)

(Left is north) (Scale: 1 cm. = 22′.0)

1855.0 α 23h 49m δ +37°.0

1892 May 30d 14h 25m P.S.T. Exposure 1h 50m

Besides the short, straight tail, there is a shorter one to the north, making a small angle with the main tail. This is nearly lost in the reproduction.

PLATE 101

DISCOVERY OF COMET V 1892

(Top is north) (Scale: 1 cm. = 14′.7)

1855.0 α 19^h 30^m δ $+12°.8$

1892 October 12^d 8^h 50^m P.S.T. Exposure 4^h 20^m

The trail of the comet is distinctly shown one inch above the dark spot—which is a real vacancy among the stars. In the original photograph the trail is very much more hazy than in the reproduction.

As this was the first comet discovered by the aid of photography, the picture was thought worthy of preservation here.

PLATE 102

COMET III 1892 (HOLMES)

(Top is north) (Scale: 1 cm. = 24'.2)

1855.0 α $0^h 43^m$ δ $+38^\circ.0$

1892 November 10^d $7^h 45^m$ P.S.T. Exposure $3^h 0^m$

This picture gives the general appearance of the comet and its surroundings shortly after its discovery by Mr. Holmes, and shows its proximity to the Great Nebula of **Andromeda**.

Some of the important details (such as the attendant mass) are lost in this reproduction. To show these, the enlargements of Plate 103 were made. The central disc and the surrounding nebulosity are fairly well preserved, however.

PLATE 103

COMET III 1892 (HOLMES)

(Top is north) (Scale: 1 cm. = 21′.6)

1855.0 α 0^h 43 δ +38°.0

1892 November 10^d 7^h 45^m P.S.T. Exposure 3^h 0^m

The two pictures are enlargements from the same original, that of Plate 102. The positive form, failing to show the connecting mass with sufficient accuracy, a negative print was made which shows it well. There is a high probability that this mass is in some way connected with the sudden appearance of the comet. It is only one of the many unique features presented by this remarkable object. The lower plate shows the large central disc surrounded with the circular nebulosity. The irregular attendant mass is also well shown.

PLATE 105

COMET III 1892 (HOLMES)

(Right is north) (Scale: 1 cm. = 16′.4)

1855.0 α 0^h 44^m δ $+35^\circ.2$

1892 December 8^d 6^h 57^m P.S.T. Exposure 1^h 15

The transition of the comet from a round, sharply defined, planetary looking object, to the regular cometary form and general appearance, is well shown in this plate when compared with those preceding it. The nature of the comet had, apparently, entirely changed, if judged from appearances alone.

The unsymmetrical appearance of the comet with respect to the middle of the plate is due to the displacement of the mask, somehow, during the process of reproduction.

PLATE 106

COMET IV 1893 (BROOKS)

(Left is north) (Scale: 1 cm. = 20′.8)

1855.0 α 12^h 23^m δ $+14^\circ.5$

1893 October 18^d 16^h 49^m P.S.T. Exposure 0^h 31^m

The plate must be turned 90 degrees for comparison with those that follow it. The main interest in this picture is to show that, for several days preceding the great disturbances of October 21 and 22, the tail was in a normal condition.

PLATE 107

COMET IV 1893 (BROOKS)

(Top is north) (Scale: 1 cm. = 19′.8)

1855.0 α 12ʰ 25ᵐ δ +15°.8

1893 October 20ᵈ 16ʰ 52ᵐ P.S.T. Exposure 0ʰ 35ᵐ

This picture is very important when compared with those that follow it, for it shows that the tail at this time was in a normal condition and that it was unaffected by the disturbing conditions of the two following dates.

The comet was covered by clouds for at least five minutes toward the end of the exposure.

PLATE 108

COMET IV 1893 (BROOKS)

(Top is north) (Scale: 1 cm = 21′.4)

1855.0 α $12^h\ 26^m$ δ $+16^\circ.5$

1893 October 21^d $16^h\ 54^m$ P.S.T. Exposure $0^h\ 35^m$

It is needless, perhaps, to call attention to the remarkable change that has taken place in the tail in the twenty-four hours' time between this plate and No. 107. It will be noticed that this disturbance seems to be met by the comet's tail in its eastward motion. In Plate 107 the western side of the tail is brightest and best defined, while in the present plate the opposite side of the tail is the strongest. The short diffused tail that was present on the east side on October 20, is, apparently, swept away by some force coming from the east. The disturbance (which seems to be from some outside influence) has greatly brightened the general tail, beside disrupting and distorting it. Apparently nothing remains that can be identified as belonging to the former tail, so great has been the change.

The sky was good during the exposure.

PLATE 109

COMET IV 1893 (BROOKS)

(Top is north) (Scale: 1 cm. = 21′.9)

1855.0 α 12^h 27^m δ $+17°.2$

1893 October 22^d 16^h 52^m P.S.T. Exposure 0^h 45^m

On this photograph the effect of the disruption of October 21 is still in progress; a large portion of the tail near the end is torn away and the main body of the tail is broken into cloud forms. The slender straight tail for about one degree from the head is evidently newly formed, and would rather suggest that the present broken appearance of the tail is simply the result of the disturbance of the 21st, the fragments not yet having dissipated into space. Four degrees from the head is an isolated mass which is separated from the rest of the tail by a large gap, as if something with a southerly motion had torn its way through the tail at that point.

The comet was covered by clouds for more than half the exposure time.

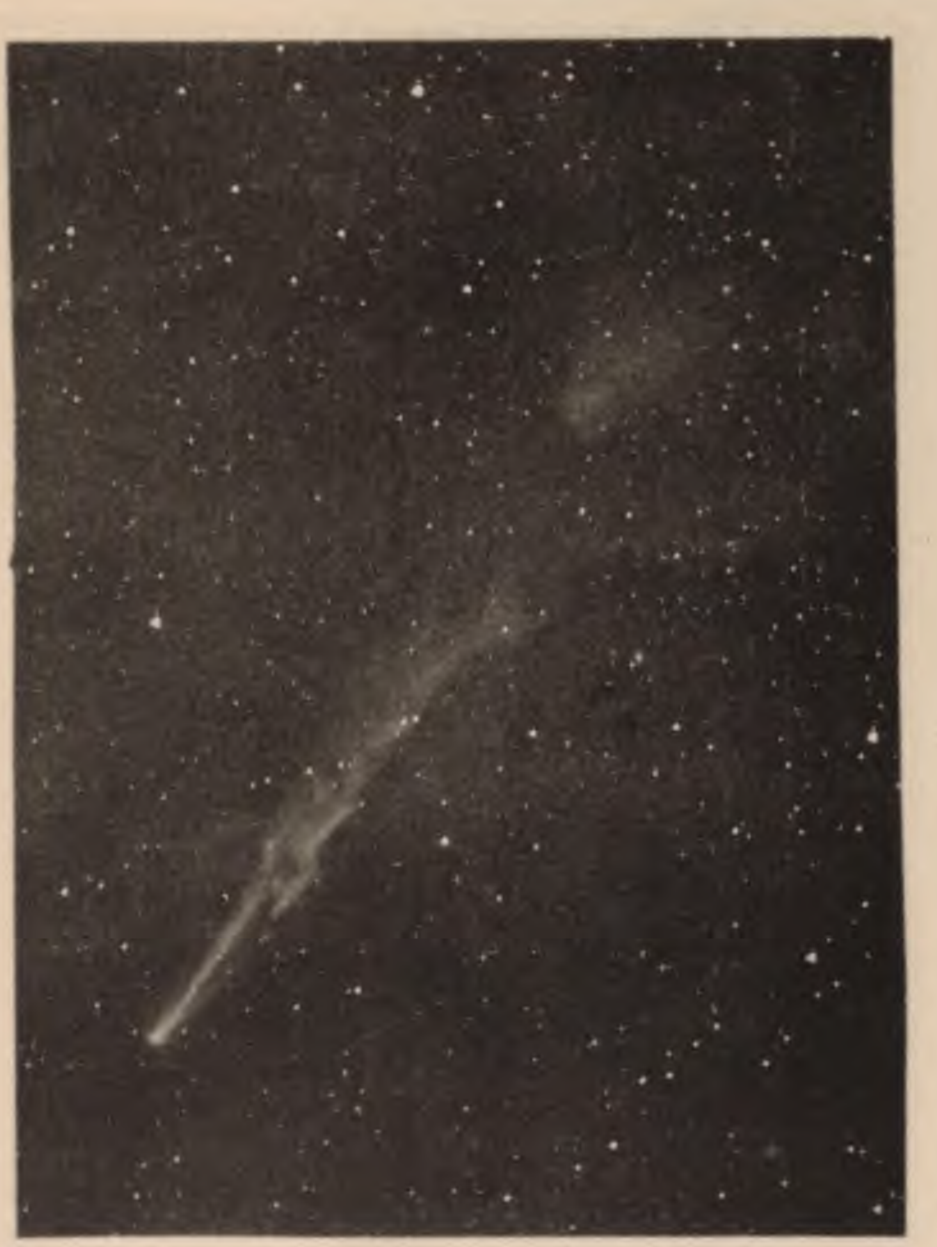

PLATE 110

COMET IV 1893 (BROOKS)

(Top is north) (Scale: 1 cm. = 21′.6)

1855.0 α 12^h 45^m δ +25°.2

1893 November 2^d 16^h 42^m P.S.T. Exposure 1^h 25^m

The tail has the appearance of "weathering" against a strong resistance, which at the end becomes so great as to bend the tail nearly at right angles to its length. In reality the entire tail appears to be thrown forward (in the direction of its motion) from its normal position. See Plate 114, and also the chart on page 32 of the Introduction.

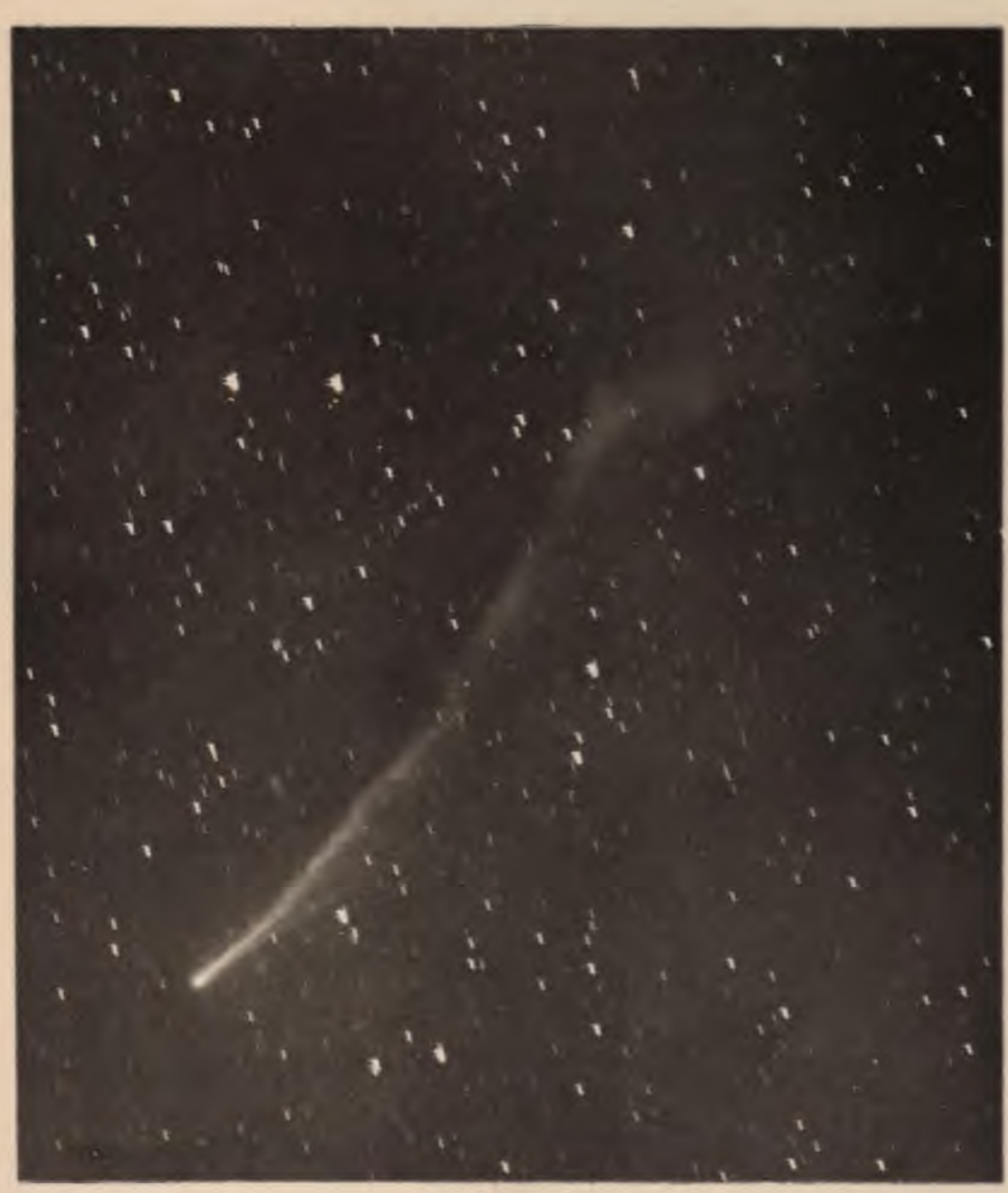

PLATE 111

COMET IV 1893 (BROOKS)

(Left is north) (Scale: 1 cm. = 22′.8)

1855.0 α 12^h^ 47^m^ δ +26°.1

1893 November 3^d^ 16^h^ 45^m^ P.S.T. Exposure 1^h^ 30^m^

This photograph has been accidentally placed the wrong way on the plate. It must be turned 90 degrees for comparison with the other plates.

In this picture the tail seems to have partly recovered from the disturbance of the previous night. One large mass is still visible at the end of the tail, and the south side is very irregular.

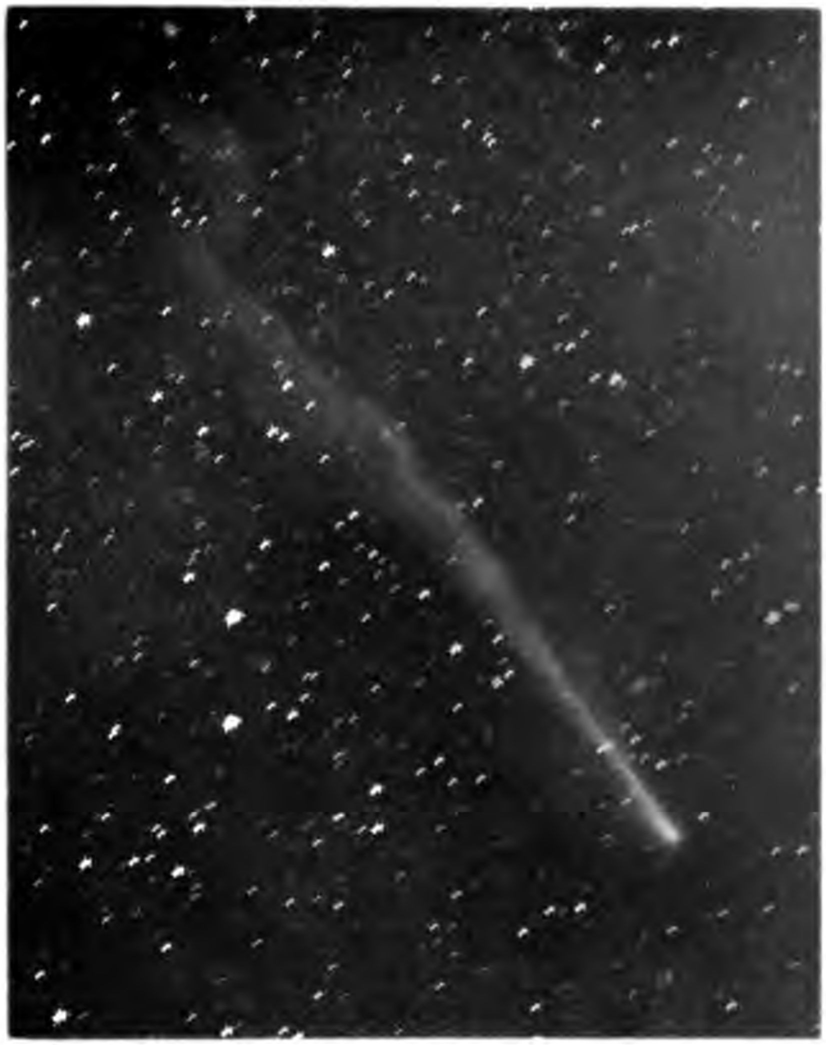

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PLATE 112

COMET IV 1893 (BROOKS)

(Top is north) (Scale: 1 cm. = $22'.4$)

1855.0 α $12^h\ 52^m$ δ $+28^\circ.5$

1893 November 6^d $16^h\ 47^m$ P.S.T. Exposure $1^h\ 25^m$

Another disturbance seems to have occurred at this time, or shortly before. The entire tail does not seem to have been affected, or perhaps the disturbance itself had ended and the straight part of the tail had been newly formed in the mean time. The small elongated mass of matter 1½ degrees from the head, in the south side of the tail, seems to be quite separated from the brighter portion near it. At about 2 degrees from the head, the tail becomes very straggling and irregular.

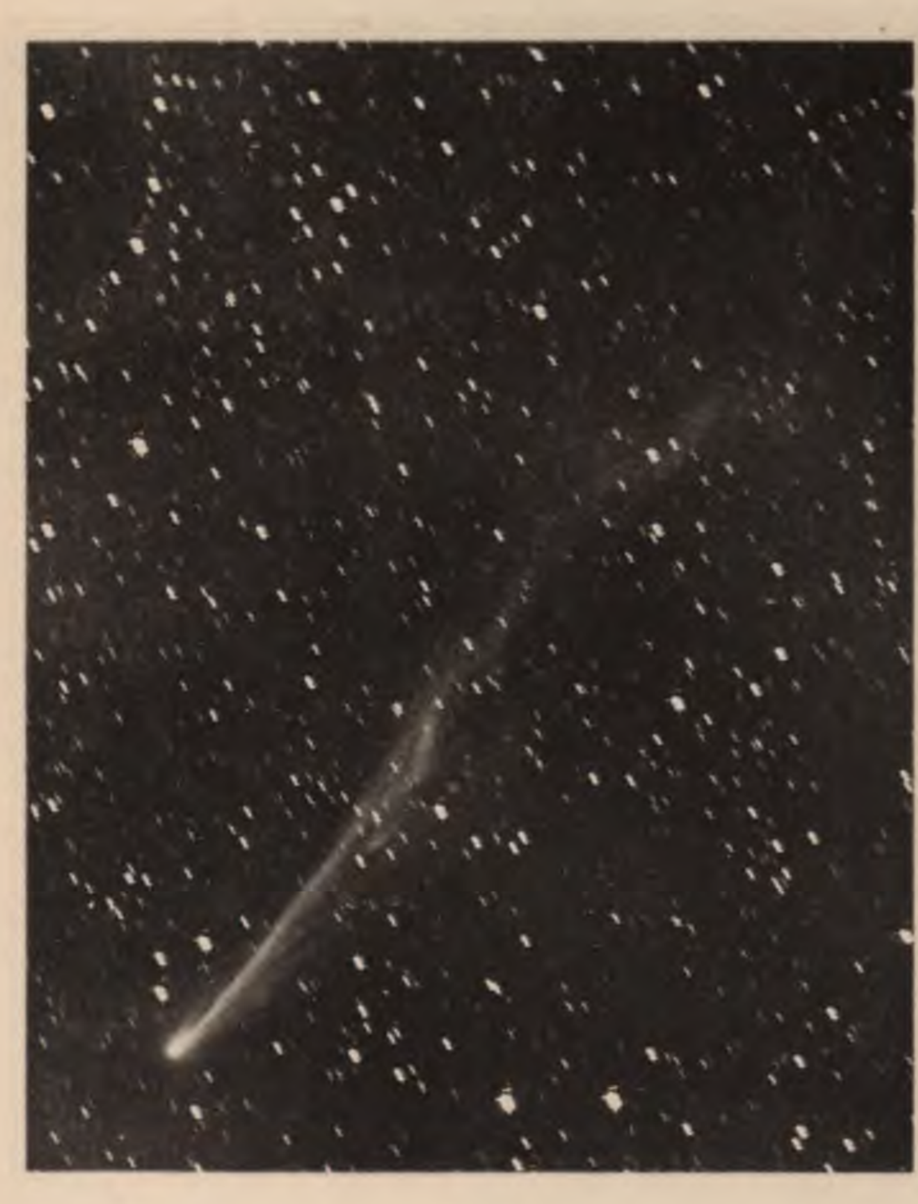

PLATE 113

COMET IV 1893 (BROOKS)

(Top is north) (Scale: 1 cm. = 40′.6)
1855.0 α 12^h 54^m δ +29°.4
1893 November 7^d 16^h 27^m P.S.T. Exposure 1^h 45^m

In this plate the tail seems to be in its normal condition, having doubtless been formed entirely anew from a fresh flow of particles since November 6, as all traces of the disturbance of that date have disappeared.

The comet was covered by clouds during the last five or ten minutes of the exposure.

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PLATE 114

COMET IV 1893 (BROOKS)

Top is north

Combinations. Upper: Plates 110–111, 1893 November 2–3
Lower: Plates 112–113, 1893 November 6–7

We have here two combinations of the four preceding plates. These combinations are made to show the large displacement in the direction of the tail on the dates of November 2–3 and November 6–7. It will be seen that in each case the first date shows a large deflection accompanied by much distortion of the tail, and that on the second date it had essentially resumed its normal condition. In both cases the deflection seems to have been in the direction of motion of the tail as if the tail had been accelerated perpendicularly to its length. See diagram, page 32.

These two combinations are remarkably similar in appearance.

The position angle of the direction of motion of the comet was 26°.3.

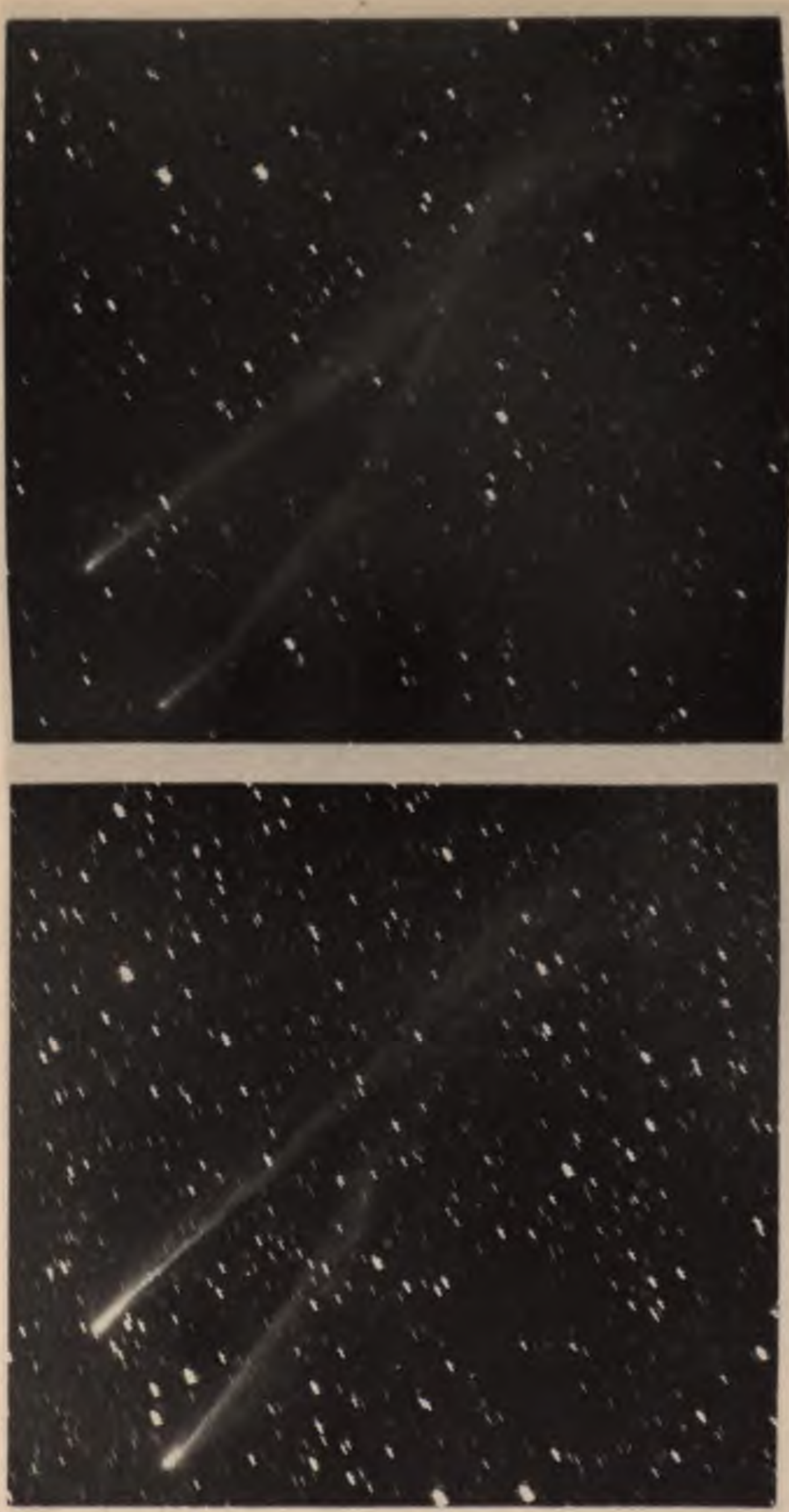


PLATE 115

COMET IV 1893 (BROOKS)

(Top is north) (Scale: 1 cm. = 33′.8)

1855.0 α 13h 1m δ +32°.1

1893 November 10d 16h 35m P.S.T. Exposure 2h 0m

This is a beautiful picture of the comet. From a small head and narrow "neck," the tail with the two short streamers forms a fan, from which the main portion stretches out in a slightly widened form. Near its end is a brighter portion which is but feebly connected with the rest of the tail by a fainter space, over a degree long. The bright star partly shown at the upper edge of the plate is α Canum Venaticorum.

PLATE 116

COMET IV 1893 (BROOKS)

(Top is north) (Scale: 1 cm. = 34′.2)
1855.0 α 13^h 2^m δ +33°.0
1893 November 11^d 16^h 46^m P.S.T. Exposure 1^h 37^m

The tail is sinuous with some very long, straight streamers on the north side. There is a bright mass, similar to the one of November 10, near the end of the tail. It is remarkable that the slender streamers on the north side of the tail should be perfectly straight, while the tail close to them is sinuous. This fact would rather oppose the idea that the inflection of the tail was due to conditions existing at that time in that part of the sky, for the streamers, which are straight, would doubtless be involved in any disturbance that affected the main tail.

PLATE 117

COMET IV 1893 (BROOKS)

(Top is north) (Scale: 1 cm. = 40′.5)
1855.0 α $13^h\ 5^m$ δ $+33^\circ.8$
1893 November 12^d $16^h\ 22^m$ P.S.T. Exposure $2^h\ 16^m$

There is nothing in the photograph of November 11 that would suggest the peculiarity shown in the outer half of the tail on the present date. To the southwest of α **Canum Venaticorum** is a large section of the tail (some 2 degrees long) entirely separate from the main tail, and displaced at an angle of about 14 degrees to the original direction. This is, perhaps, a portion of the tail of November 11 which has become disconnected, and has drifted to the northeast in the general direction of the combined motion of the comet and the tail. The straight part of the tail, which is about 5 degrees long, is somewhat irregular. It is doubtless newly formed since the 11th.

PLATE 118

COMET IV 1893 (BROOKS) AND LARGE METEOR TRAIL

(Top is north) (Scale: 1 cm. = 49′.9)

1855.0 α 13h 7m δ +34°.9

1893 November 13d 16h 27m P.S.T. Exposure 2h 5m

The principal interest in this plate lies in the beautiful meteor train. The meteor appeared near the middle time of the exposure. It was a brilliant object to the eye and exploded just outside the limits of the plate. The beginning of the trail is shown and almost the full flight of the meteor. The coincidence of the appearance of this meteor with the date of the "November meteors" would suggest that it was one of those bodies. This, however, was not the case, for its radiant was in another part of the sky.

PLATE 119

COMET IV 1893 (BROOKS) ENLARGED

(Top is north) (Scale: 1 cm. = 24′.0)

1855.0 α 13^h 7^m δ +34°.9

1893 November 13^d 16^h 27^m P.S.T. Exposure 2^h 5^m

This is an enlargement from the picture of Plate 118. It was made to show the peculiar structure of the tail where it widens out near the star in its middle and its fragmentary condition beyond that star. It extends some distance beyond α **Canum Venaticorum** in a straggling manner. The change in the appearance of the tail in the 24 hours has been very great.

PLATE 120

COMET IV 1893 (BROOKS)

(Top is north) (Scale: 1 cm. = 37′.4)

1855.0 α 13^h 10^m δ +35°.7

1893 November 14^d 16^h 6^m P.S.T. Exposure 3^h 2^m

The tail, which is somewhat sinuous, can be traced faintly some distance north of and beyond α **Canum Venaticorum**, where it seems to bend northward.

PLATE 121

COMET IV 1893 (BROOKS)

(Top is north) (Scale: 1 cm. = 38′.7)
1855.0 α 13^h 11^m δ +36°.8
1893 November 15^d 16^h 52^m P.S.T. Exposure 1^h 27^m

A few irregular luminous defects appear in the upper part of the plate and near the end of the tail. Apparently none of the features belonging to the tail on the 14th are present in this picture, which slightly resembles that of Plate 115.

PLATE 122

COMET IV 1893 (BROOKS)

(Top is north) (Scale: 1 cm. = 38′.4)
1855.0 α 13h 22m δ +40°.7
1893 November 19d 16h 36m P.S.T. Exposure 2h 3m

The slightly luminous condition of the plate near the end of the tail is a defect. There seems to be a break in the tail at the four or five bright stars two degrees from the head.

PLATE 123

COMET II 1894 (GALE)

(Right is north) (Scale: 1 cm. = 32′.7)
1855.0 α $7^h\ 30^m$ δ $-22^\circ.2$
1894 April 29^d $8^h\ 35^m$ P.S.T. Exposure $1^h\ 0^m$

The low altitude of the comet doubtless prevented more of the tail being shown in this picture.

PLATE 124

COMET II 1894 (GALE) ENLARGED

(Right is north) (Scale: 1 cm. = 17′.6)

1855.0 α 8h 8m δ −9°.7

1894 May 2d 8h 37m P.S.T. Exposure 1h 15m

The increasing altitude of the comet shows more of the tail in this plate. There is, however, little of interest in it.

PLATE 125

COMET II 1894 (GALE)

(Right is north) (Scale: 1 cm. = 32′.2)

1855.0 α 8^h 19^m δ $-5^\circ.7$

1894 May 3^d 9^h 27^m P S.T. Exposure 2^h 15^m

The tail remains straight and slender, while the head is large and round.

PLATE 126

COMET II 1894 (GALE)

(Right is north) (Scale: 1 cm. = 32′.7)

1855.0 α 8^h 29^m δ −1°.7

1894 May 4^d 9^h 42^m P.S.T. Exposure 2^h 5^m

The general appearance here is that the force forming the tail has changed its activity and begun to send out material for a broader tail. There really are three slender tails shown on the original, one on each side of a main branch and but little inclined to it.

PLATE 127

COMET II 1894 (GALE)

(Right is north) (Scale: 1 cm. = 31′.6)
1855.0 α 8^h 41^m δ $+2^\circ.2$
1894 May 5^d 10^h 0^m P.S.T. Exposure 2^h 30^m

The straight and slender appearance of the tail in this picture gives one the impression that it has been shot out with very great velocity. About 2 degrees from the head, the tail broadens into two parts, neither of which seems to exactly coincide with the original direction.

PLATE 128

COMET II 1894 (GALE)

(Right is north) (Scale: 1 cm. = 32′.1)

1855.0 α 9^h 7^m δ +11°.7

1894 May 8^d 10^h 11^m P.S.T. Exposure 2^h 28^m

The activity of the comet seems to have ceased, as but little of the tail is shown, and this of a brush like nature.

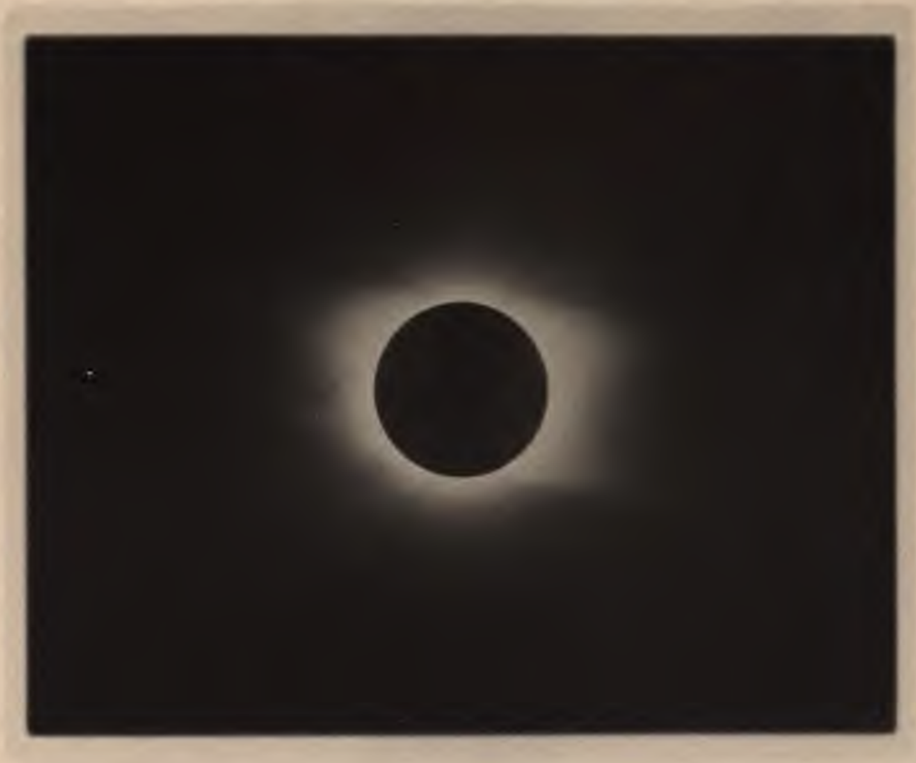
PLATE 129

TOTAL ECLIPSE OF THE SUN (ENLARGED TWO TIMES)

(Top is south) 1889 January 1

This reproduction is not satisfactory. I would refer to the silver print made from the same original, bound in with the *Reports on the Total Eclipse of the Sun of January 1, 1889*, which shows the details of the fans and the extensions better than the present plate. In the original negative the individual streamers in the fans are beautifully shown.

One peculiarity which I have noticed for a great many years when looking at photographs of the corona, is the dissimilarity of the details of the north and south polar fans. The individuality of each is so marked that one readily picks out the north or south fan at a glance. The north fan is made up of definite and slender rays sharply defined and well separated, while the southern is partly composed of broader and more diffused rays or beams, which occur more or less in bunches. I am not sure that this holds good for the symmetrical or "sun spot maximum corona," but it seems to do so for the "sun spot minimum" or extended coronas. It is strikingly shown in the coronas of January 1, 1889, and May 28, 1900.



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